ADDIS ABABA UNIVERSITY

FACULTY OF VETERINARY MEDICINE

SMALLHOLDER DAIRY PRODUCTION TECHNOLOGIES UPTAKE IN MIXED FARMING SYSTEM IN DEJEN WOREDA OF EAST GOJJAM ZONE, AMHARA REGIONAL STATE

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DEHINENET GEZIE WOLDEMICHAEL

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DEBRE ZEIT, ETHIOPIA

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A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master in Tropical Animal Production and Health

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Dedication

This M.Sc.thesis manuscript is dedicated first, for Almighty GOD and His mother then to my families and parents.

BIOGRAPHY

The author was born in Awabel "woreda", East Gojjam Zone of Amhra National Regional State, in June 1973. He attended his elementary and junior secondary education at Lumamme elementary and junior secondary school. Then, he joined Gojjam Ber secondary high school and accomplished his secondary education in year 1992/93.

In year 1992/93, he was not successful to pass the Ethiopian School Leaving Certificate Examination (ESLCE) and, thus, the author joined Debre brehan Teacher Training Institute (TTI) and certified to be an elementary school teacher in July 1994. The author, after he has served for six years (1994-1999/2000) in elementary school, reappeared in Ethiopian school leaving certificate examination privately and successfully passed the exam and joined Mekelle University in 2000. The author graduated from Mekelle University, faculty of agriculture in B.Sc. of Animal Science and Range Management (ASRM) at the mid of July 2003.

After graduation, the author employed in Mertule Mariam Agricultural, Technical, Vocational, Educational and Training (ATVET) College and has served as department head for two years (2003-05) and still he is an Instructor in the college in department of Animal Science.

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ABBREVIATIONS

AI	Artificial Insemination
ARDU	Arsi Rural Development Unit
ATVET	Agricultural Technical, Vocational and Educational Training
bST	bovine Somato Tropine
BoFED	Bureau of Finance and Economic Development
CADU	Chilalo Agricultural Development Unit
CSA	Central Statistical Authority
CTA	Center for Tropical Agriculture
DDA	Dairy Development Agency
DMI	Dry Matter Intake
DRDP	Dairy Rehabilitation and Development Project
DWARDO	Dejen “woreda” Agricultural and Rural Development Office
EARO	Ethiopia Agricultural Research Organization
EPID	Extension and Project Implementation Department
ET	Embryo Transfer
FAO	Food and Agriculture Organization
FAO/WFP	Food and Agriculture organization/ World Food Programme
FINNIDA	Finland International Development Agency
GLM	General Linear Model
GnRH	Gonadotrophic Releasing Hormone
HARC	Holleta Agricultural Research Center
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
LDCs	Less Developed Countries
m.a.s.l	meter above sea level
MB	Mineral Blocks
MOA	Ministry Of Agriculture
NAIC	National Artificial Insemination Center
NDDB	National Dairy Development Board
OIE	Office International des Epizooties
PA	Participatory Appraisal

PAs	Peasant Associations
SDDP	Smallholder Dairy Development Project
SNF	Solids-Not-Fat
SPDDPP	Selale Peasant Dairy Development Pilot Project
SPSS	Statistical Package for Social Sciences
TLU	Tropical Livestock Unit
WADU	Wolaita Agricultural Development Unit

ABSTRACT

A cross sectional study on smallholder dairy production technologies uptake in mixed farming systems in Dejen “woreda” was conducted from September 2007 to May 2008 with the objectives to identify available technologies, their uptake levels and constraints, assess the influences of these technologies on milk production and reproductive performance of dairy cattle in the study area. Totally, 240 randomly selected smallholder farmers and six participatory appraisal discussion groups were included in the study. Information was collected by questionnaire survey, personal observation during farm visits and through participatory appraisal group discussions. The average family size in the study area was 5.38 $\pm$ 1.96 ranging from 1 to 11 persons while the average land holding and livestock size were 1.41$\pm$ 0.68 and 5.01 TLU respectively. Cattle represented the largest proportion [49.5 % (4.14 TLU)] of the livestock population. Cows were 30.3% of cattle herd and 20% of them were crossbred. The average daily milk yield was 1.46$\pm$ 0.99 and 6.01$\pm$ 3.20 liters for local and crossbred cows respectively. Totally, 25 dairy technologies practiced by smallholder farmers were identified in the study area. Technologies that were widely used (more than 80% uptake levels) were modern endo-parasite treatment, vaccination, estrous detection and haymaking. Technologies such as pregnancy test, modern ecto-parasite treatment, total and partial stall feeding, crossbreed cattle, forage development, feed supplement, artificial insemination (AI), separate type of house, bull station, udder washing and record keeping were at intermediate uptake level. Modern milk processing, urea treated straw (UTS) and silage were the least practiced technologies with an uptake level of 1.7 to 14%. Associations of technologies uptake with different farm household characteristics of smallholders were tested by using one way ANOVA. Male headed households adopted significantly ($P<0.001$) higher number of technologies than female headed households. The larger the family size the higher the number of technologies adopted ($P<0.01$). Number of technologies adopted were also significantly ($P<0.01$) increased with the level of education. Distance from technologies supply site was inversely correlated with technology uptake. The households that lived within 10 kilometers radius from technology dissemination source adopted more number of dairy technologies ($P<0.05$) than those living beyond that distance. Technologies had significant effect on milk production and reproductive performance of dairy cows. Genetics (crossbreeding) had significant effect ($P< 0.001$) on milk production and on reproductive performances of dairy cows. The number of technologies adopted by smallholder farms and milk yield of cows had a positive linear relationship in both local and crossbred cows. Feed scarcity, unavailability of technologies like improved cattle breed, forage seed, AI and veterinary services, inadequate extension service, financial problem, land scarcity, cost of inputs, lack of labor and low price of milk were indicated, in declining order of importance, as constraints for technology uptake. From this study, it was recommended that the government should encouraging the establishment of new dairy cooperatives and further strengthening the existing ones. The government should invite and encourage private sector to be widely involved in animal feed production and processing. The establishment of a dairy institute, at least at federal level, is strongly recommended. The institute will have a role in providing training to dairy farmers and different level of professionals. It will also do adaptive research of technologies and technology popularization. Credit and saving institutions, instead of lending money if could provide technologies (crossbred, concentrate feed, etc...) in kind form. Further research was suggested to determine impact of dairy technologies on household economy.

Key words: Dairy**,** Smallholder, Technologies Uptake, Constraints, Milk yield, Reproductive performance

1. INTRODUCTION

Livestock production is an important component in the economy at both the national and farm household levels, where cattle constitute the main livestock species kept by farmers. Estimation made by the Ministry of Agriculture (MOA, 1997) indicates that Ethiopia has one of the largest livestock populations in Africa with 87.1 million grazing livestock equivalent to 35.0 million TLU. The annual animal population growth is estimated at 1.3 % for cattle, 1.0 % for sheep and 0.9 % for goats (Getachew and Gashaw, 2001). The latest animal population census shows that Ethiopia has 39 million cattle, 18 million sheep and 15 million goats, which exclude nomadic areas (CSA, 2006).

The main source of milk in Ethiopia is the cow. Dairy production is becoming increasingly important in many developing countries including Ethiopia due to its ability to generate significant amount of daily cash income and its contribution to the improvement of the livelihoods of very poor people. The estimated total milk production in Ethiopia ranged from 960, 000 metric Tons for 1994 to 1,197,650 metric tons for 2000 showing meager growth (Getachew and Gashaw, 2001). This low production is reflected by the very low per capita consumption of animal protein. The average per capita consumption of milk in Ethiopia, Africa, developing world and the world was 19.2kg, 27.5kg, 36.6kg and 75kg respectively (FAO, 1992). The per capita consumption of milk in Ethiopia is, thus, only 52.5% and 15-30% that of developing and developed countries respectively (Azage and Alemu, 1998).

Livestock production in Ethiopia is mainly of traditional farming system with an animal having multipurpose use and being managed in traditional ways. The reduction of milk consumption levels and the fact that the country is importing milk products while possessing a large livestock population is a very good indicator of the complexity of the problem. Local cattle are , generally, characterized by low daily milk yield (1.17kg), short lactation length (195 days) and extended post partum period (Mukessa-Mugerwa *et al*., 1989).

According to FAO (2005) the rapid and steady increase in the total human population of the country (estimated at 72.4 million) and urbanization are expected to add more stress on demand for dairy products because of higher elasticity of demand for milk and milk products. To meet the increasing demand for milk and milk products, improvement of the productivity of dairy cattle through appropriate technologies such as breeding programmes, intensification of the dairy production systems and development of market infrastructures and others are crucial steps (Zumbach and Peters, 2000). An annual increase of milk production of 4% is said to be necessary to meet the demand. Smallholders are believed to have a comparative advantage in rearing dairy cows because of the high labor requirements of the activity and the great care that dairy cows need to reach their genetic potential (Baltenweck and Staal, 2000).

Even though limited in area coverage and less participatory in approach, efforts have been made to disseminate improved dairy technologies to the farmers through various means. Fore instance, farmers with grade cows are usually market oriented since the higher production levels enable them to sell the surplus milk. The introduction of crossbred cows, which is one of the technologies, in small-scale dairy farm in Ethiopian highlands is said to have doubled farm incomes (de Leeuw *et al*., 1999).

Although dairy technologies are believed to have positive impact on the smallholder farmers` production performance and promote agricultural development (Kaitho *et al.*, 2001), adequate data is lacking on the rate of uptake. Factors that limit dairy technologies uptake also were not systematically identified and prioritized (EARO, 2000).

Therefore, the objectives of this research project were to:

1. Identify available technologies, their uptake levels and constraints in the study area.
2. Assess the influences of these technologies on milk production and reproductive performance of dairy cattle in the study area.

2. LITERATURE REVIEW

2.1 Dairy production systems in Ethiopia

Four major systems of dairy production can be distinguished in Ethiopia. These are lowland pastoral dairy production systems, rural highland smallholder dairy production system, urban and peri-urban small-scale dairy production system and large-scale dairy production system (Kelay, 2002).

2.1.1. Lowland pastoralist dairy farming

About 30% of the livestock populations in Ethiopia are found in the pastoral areas. These areas comprise 50% of the total land area of the country and have altitudes below 1500m.a.s.l. Pastoralism is the major dairy production system in the lowland. Livestock does not provide inputs for crop production but are the very backbone of their owners providing all of the consumable and saleable out puts and regarded as insurance against adversity. Milk production is dependent on season due to the rainfall pattern that influences feed availability (Ketema and Tsehay, 1995; Kelay, 2002).

2.1.2. Rural highland small-holder dairy farming

There are two types of systems in the highland. The traditional system that is based on local breeds and the market oriented system that is based on crossbred dairy cattle. The average lactation yield for local cows is 524 liters for 239 days and the average age at first calving is 53 months and the average calving interval is 25 months (Kelay, 2002). Tesfaye (1995) as cited in Kelay (2002) the average milk yield and lactation length for crossbred dairy cows ranges from 518.8-1448 kg and 110-300 days respectively, depending on the breed type. The household mainly consumes the milk produced in the traditional system while most of the milk is sold to generate income in the market-oriented system. Livestock plays a vital role in the highland settings through provision of draught power for crop production, serves as source of supplementary family diet, manure for soil fertility and fuel and source of cash income (that is from the sale of livestock and livestock products) particularly when markets for crops are not favorable (Belachew, 2003; FAO, 2005).

2.1.3 Urban and peri-urban small scale dairy farming

This system is developed in and around major cities and towns located mainly in the highlands of Ethiopia. The main feed resources are agro-industrial byproducts and purchased roughage. The system comprises small and medium sized dairy farms that own crossbreed dairy cows. Farmers use all or part of their land for forage production. The primary objective of milk production is generating additional cash income to the household (Ketema and Tsehay, 1995; Kelay, 2002).

2.1.4. Large scale dairy farming

This system is a specialized market oriented dairy operation practiced by the state sector and very few private commercial farms. Most of these farms are located in and around Addis Ababa and keep exotic dairy stock (Ketema and Tsehay, 1995; Kelay, 2002).

2.2. Constraints of livestock production and productivity

2.2.1. Technical and biological factors

Feeds and nutrition

The availability, quantity and quality of feed that are commonly given to animals are questionable. In Ethiopia, livestock mainly depends on grazing or on crop residues that are of poor nutritive values. These feeds are high in fiber and low in nutrient contents. Animals are not provided with supplements of feed of a relatively better quality. This significantly affects the productivity as well as the well-being of animals. On top of this, the recurrent drought problems that occur in the country heavily affect the quantity and quality of feed that are available for livestock and similarly contributed to the deaths of thousands of animals (ILRI, 2000a).

Genotype of local breeds of animals

Local animals are generally of low genetic merit. Little or no selection has been done so far for improving out puts from livestock in Sub-Saharan Africa, including Ethiopia compared with those animals in temperate climates. Similarly, animal improvement schemes are poorly defined and infrastructure for improvement is inadequate, e.g. poor artificial insemination services. Additionally, there is no clear definition or policy for animal genetic resources in the country. The productivity of current genotypes remains low due to late maturity and age at first calving. Therefore, the productivity of the local breeds did not match with their large numbers (ILRI, 2000a).

Diseases and inadequate health care

Among the major problems, affecting sustainable livestock production and productivity are animal diseases. Out of the fifteen Office International des Epizooties (OIE) List-A diseases known for their rapid spread and serious socio-economic or public health consequences and which affect international livestock trade, seven of them are endemic to the country (Foot and Mouth Disease, Contagious Bovine Pleuropneumonia, Peste des Petits Ruminants, Lumpy Skin Disease, Sheep Pox, African Horse Sickness and Newcastle disease). These diseases invariably exert considerable effects on the productivity of animals and can seriously affect the livelihood of farmers, their families and the country's export trade (Bedane, 1999).

In Ethiopia, similarly trypanosomosis in cattle is a serious constraint to livestock production, mainly in tse-tse infested areas of South and Southwestern part of the country. In these areas, tse-tse flies infest over 66, 000km^2 of potentially fertile land. In Ethiopia, at least 6 million of the 30 million cattle of the country are exposed the disease (Abebe and Yilma, 1996). Diseases in general cause mortality of large number of animals and could affect the performances of animals.

Management and other constraints

The continuing human population pressures in Ethiopia lead to further expansion of cropland sizes and this consequently forces to concentrate livestock in marginal and mountainous areas. This, therefore, increases livestock densities in a given area with ultimate overgrazing and land degradation. This is very true in those livestock production systems that depend on grazing of mainly native grassland, with no or only limited integration with crops (MOA, 2004).

2.3. Technologies practiced in dairy farming

2.3.1. Technologies practiced in forage development

Various fodder interventions (maize, sorghum PC 23, hybrid napier-Co1/2, guinea grass and Lucerne, etc) were promoted under irrigated conditions in a smaller area alongside the farmer's priority of their staple crop of paddy. Most farmers initially refused to spare their land as irrigated land possessed by them. However, four farmers including a woman farmer from Anantapur cluster came forward to take up Napier planting in her field. All farmers were supplied with the cuttings for an area of 1/10 of an acre. Only the women farmer retained the cuttings and other farmers removed them. After she successfully grew the fodder and started feeding to her milch animals, which has resulted in increased milk production and quality of the milk. Seeing this benefit, many farmers in Anantapur cluster came forward to take up fodder cultivation. Now at present around 163 farmers representing all socio-economic classes are growing hybrid napier-Co1 fodders (Misra *et al*., 2007).

Measurements made in farmers' backyards throughout Ethiopia showed a forage yield of 195 kg of dry matter (DM) per year from 50 m of hedge and 100 m^2 of herbaceous legumes (Alemayehu *et al*., 1988) with large variations between sites.

2.3.2. Technologies in animal feeds and feeding system

The major sources of livestock feed were grazing, hay and crop residues. The study conducted by Tuomo (1993) in Selale area of North Shewa zone also reported that grazing, natural pasture, hay and crop residues make the basal diet of livestock. Some palatable weed species from the crop fields were also important sources of livestock feed. However, feed availability is becoming a critical factor determining livestock production. Farmers reported that more pasture and grazing lands are being cropped leaving unproductive marginal and waterlogged areas for grazing. This forced farmers to shift to crop residues to minimize the problem of feed shortages.

Fekadu and Alemu (2000) also reported that farmers utilized more crop by-products to feed their cattle to overcome the shortage of feed resources. Chilot and Elias (1998) indicated that about 71% of the sample farmers in Ambo and 34% in Tikur Enchini "woreda"s practiced annual fallowing. Results of the study in North Shewa zone also reported that about 43.4% of the sample farmers in Degem and 61.5% in Gerar Jarso “woreda”s practiced annual fallowing (Chilot *et al*., 1998). Critical months of feed shortages occurred specially in June and July. This was because croplands are cultivated during this period, available grazing lands become too wet and hence the fields get muddy.

To overcome the feed shortage problem, farmers used different measures. In North Shewa zone, a large proportion of sample farmers (83%) conserved crop residues to feed their animals during the months of acute feed shortages. A large proportion of sample farmers (72%) also fed weeds from croplands. Hay was mainly fed in the dry season (81%) and few farmers (18%) fed in the wet season. Hay and crop residues were mainly fed during the dry season when green feeds are limited. Oat is very important crop in the short rainy season (belg) and fed during the main rainy season (June - August) especially in North Shewa zone (Agajie *et al*., 2001).

2.3.3. Technologies in animal breeding

Varieties of modern reproductive technologies are now available to livestock breeders and these have revolutionized livestock production in industrialized countries. While some of these technologies are also applicable in tropical smallholder dairy systems with little modification, others require comprehensive evaluation and adaptation under specific local conditions before they can be used effectively (Perera, 1999).

Estrous detection

The accurate and efficient detection of estrus (heat) in dairy cattle is an important component of a good reproductive management program. Failure to observe cows in estrus is the biggest cause of reproductive management problems in most herds. Individual cows may not be observed in estrus for one or two reasons. First, the ovaries of the cow are not functioning properly and the cow is anestrous (failure to have an estrous cycle). The second reason is that the dairy producer misses seeing a cow that actually is in estrus. While the second reason is the most common in herds, it is uncommon for a particular producer to have both problems in a herd. The extent of these problems varies greatly among herds (Britt *et al*., 1974).

The percentage of cows in a herd without a normal estrous cycle by 60 days can range from less than 5% to over 20%. The percentage of missed estrous periods can range from less than 15% to over 60%. Anestrous or missed estrous periods can significantly reduce profits. It is important that dairy producers who are having problems detecting cows in estrus determine which of the two causes of the problems are most important for their herd. This describes a method of determining whether anestrous or missed estrus is the major problem in estrous detection for a herd (Britt *et al*., 1974).

Crossbreeding

The basic objectives of crossbreeding of high performing cattle breeds with tropical breeds are to produce crossbreds with an expected additive genetic merit being the mean of both parental breeds. The non-additive effect, which is observed as heterosis or hybrid vigor, is the amount by which merit in crossbreds deviate from the additive component (Kinghorn, 2000; Kelay, 2002) and is fully exploited only when non-related breeds are crossed. Payne and Hodges (1997) indicated that hybrid vigor becomes greater when the difference in the parental genetic make-up is high. The use of temperate dairy breeds for crossbreeding with local breeds has been widely accepted and aimed at combining the superior performance of specialized dairy breeds with the superior adaptability of the local stock (Peters, 1991; Kelay, 2002).

According to Cunningham (1991), the crosses between the temperate dairy cattle breeds and local cattle in the tropics combined the milk producing ability of the temperate breeds with the climatic adaptability of the tropical breeds. However, the delicate balance between genetic performance ability and adaptability is determined by the degree of exotic inheritance (Peters, 1991; Kelay, 2002). Many reports on the performance of crossbred cattle indicated that crossbreeding results in performance improvement only until 50% inheritance of Bos taurus genes.

Natural mating (bull station)

The use of bulls for natural service remains widespread even in areas where artificial insemination has proven to be very efficient. Many farmers believe that pregnancy rates are higher when a bull is used. The use of natural service may be indicated when personnel are inefficient to perform the tasks associated with heat detection and the techniques of AI, when long term genetic gain is of minor importance and when local conditions do not provide the infrastructure necessary for successful AI (Wattiaux, 1998; Kelay, 2002).

Selecting for breeding soundness of bulls in undertaking natural mating, the bull must be morphologically and functionally sound. Testicles should have a distinct neck and should not be fibrotic or flaccid in consistency. This is essential because testicles must be a reasonable distance away from the internal body temperature. A scrotal circumference of 30 cm and 34 cm is recommended for 15 months old and 24 months old Friesian bulls respectively (Kelay, 2002). Azage et al. (1995) indicated that there is a direct relationship between scrotal circumference and semen production.

Appropriate attention should be given to factors affecting fertility of bulls that include unbalanced nutrition (under feeding and over feeding) and diseases. Adequate nutrition is vital, since it hastens puberty and body development. It is also important to keep in mind that overfeeding can lead to reduce libido (Sprott *et al*., 1998; Kelay, 2002). Bulls should also be tested for venereal diseases like Brucellosis, Trichomonosis and Vibriosis that affect fertility and culled if they react positively. In addition, prevention measures like vaccination and deworming should be undertaken against other diseases that influence fertility indirectly (Sprott *et al*., 1998; Kelay, 2002).

It is important to undertake a regular fertility test for bulls to verify their external physical soundness, reproductive health (congenital and inflammatory problems), and scrotal circumference and semen quality. Lee *et al*. (1998) and Kelay (2002) indicated that up to 20% of all bulls have less than optimum fertility. To avoid undesired mating, farmers should castrate all other bulls they have and prevent outside bulls from coming into the herd.

Artificial insemination

The implementation of artificial insemination services dates back to 1950 and 1960 when teaching institutions and Dairy Development Agency (DDA) started the service using fresh and imported semen. Chilalo Agricultural Development Unit (CADU) expanded the service with establishment of the Asela Artificial Insemination center in 1972. The National Artificial Insemination Center (NAIC) was then established in 1981 with the mandate to serve at country level. Initially, service was based on production and use of fresh semen until the liquid nitrogen plant was installed in 1984. Bulls donated by Cuban Government (25 Holstein and 10 Brahman) and importation of 44,800 doses of Friesian and 2,000 doses of Jersey semen were source of semen used for frozen semen technology (Getachew and Gashaw, 2001). The center operates well-equipped semen processing laboratory and liquid nitrogen processing plants.

To date semen collection was based on exotic and local as well as crosses of these breeds namely Friesian, Jersey, Brahman, Boran, Barka, Fogera, Horo, Sheko and crosses of 50% and 75% Holstein-Friesian and local bulls. From the total semen produced the major share is from Friesian (75.3%) followed by Jersey (10.5%). Asela dairy farm was used as rearing and training center of bulls with the provision of semen collection and small quality control laboratory. Kaliti is serving as the main semen collection and preservation center, the satellite AI centers to be used for services and the recently acquired Holleta bull dam farm will be the base for nucleus bull producing, testing and rearing farm (Getachew and Gashaw, 2001).

Pregnancy diagnosis

Pregnancy diagnosis is an important element in any breeding program. According to Frederico and Hansen (2003), there are several methods of pregnancy diagnosis in cattle. Some of them are rectal palpation, milk progesterone test, blood progesterone test, pregnancy specific proteins and ultra sound scanning. Rectal palpation is probably the most commonly used method for pregnancy diagnosis. This technique allows palpation of pregnancy through the rectal and uterine walls for fetal membranes, cotyledons and fetus. (Roberts, 1986; Frederico and Hansen, 2003).

Rectal palpation provides the advantages of being accurate, fast, relatively cheap method that is less labor intensive as compared to the other methods. Nonetheless, training is necessary and the examination should be conducted by a veterinarian or by an experienced herds man. The main disadvantage of rectal palpation is that it cannot be performed until later gestation than some other methods. Some experienced veterinarians are able to determine pregnancy by palpation as early as 35 days after insemination (Roberts, 1986; Frederico and Hansen, 2003).

2.3.4. Technologies in animal health care

Vaccination is a practice of artificially building up in the animal's body immunity against specific infectious diseases (Sastry and Thomas, 1981). Vaccination is used to develop an immune zone all around an area of actual infection and this prevents the spread of disease.

In hot and humid areas, it is almost essential to deworm livestock regularly (Sastry and Thomas, 1981). Most animals have a certain amount of internal parasites. Severe worm infestation, however, causes a severe drop in milk production and growth. Adult animal develops some resistance to worms but calves suffer badly from worm infestation. In places where heavy endo-parasite infections are found it is advisable to deworm dairy cows twice a year.

External or ectoparasites are major problem in Ethiopia (SDDP, 1998). Ticks, flies, fleas and lice infect dairy cattle with dangerous and often fatal diseases. Regular spraying or dipping is the only reliable methods in external parasite control. Dipping is not practical in most areas, so spraying for ectoparasites is a more appropriate technology because it can be done regularly and at a low cost (Sastry and Thomas, 1981).

2.3.5. Technologies in housing

Good housing improves milk production by reducing stress, disease hazards and making management easier. In tropics, climatic and environmental stress, particularly heat stresses, could affect animal productivity (Mattewman, 1993). Sign of stress include loss of appetite, reduced daily milk yield, increased temperature, high respiratory rate, tongue protruding etc. Thus, the owners should be able to recognize the signs and try to adjust the environment and housing to reduced stress and let the animal be as comfortable as possible.

According to Aiumlamai (1999), herd management practices in cow handling, nutrition, milking procedures, sanitation and housing play major roles in predisposing the individual animal as well as herd to disease. Thus, herd management practices combined with a veterinary program can be most effective in optimizing production and profitability through prevention of diseases.

2.3.6. Technologies in animal husbandry

Animal identification

Identification of dairy cattle requires preliminary planning. Their name or a number depending on the preference of the smallholder may identify animals. The obvious use of identification and records is when somebody assists in milking and the identification of an individual cow can be used to provide specific instructions about any special care needed during milking. Information should be recorded when it occurs. A good herd recording system will include identification of each calf as soon as possible after birth (Risstrom, 1999). In addition to the identification name or number, the calf's birth date, its size, name and its sire and dam's name should be recorded on a simple identification record.

Identification system may be either temporary or permanent. Ear tags, neck chains, and ankle tags are usually temporary as an animal allowed to exercise or graze in a field can easily lose them. Permanent marks are those, which cannot be lost and include hot brand freeze brands, and tattoos and photographs. All identification systems have drawbacks such as the difficult application of brands and tattoos (Risstrom, 1999). For this reason, a combination of systems may be used. Where animals are maintained in a stall, a stall name plate may be the most appropriate record. This may be made of durable paper or a blackened board on which the cow's name or number, date bred, date of calving, milk and fat production, feed type, recent health interventions and other information are recorded (Risstrom, 1999).

Record keeping

An important aid for farm management is the keeping of records of all animals and events relating to animals throughout their lives. In some countries, record keeping is provided, supported and designed by the government or dairy cooperatives. Records should be kept as individual cow cards or at the dairy health services or AI service center (Aiumlamai, 1999). Records are an indispensable component of modern dairy farming, but are usually non-existent on most smallholder farms (Perera, 1999). The animals may be identified only by name and are often confused, even by the farmer. Awareness among farmers about the purpose and value of recording has been minimal. Recording is usually linked with government control on the activities of the farm. The keeping of dairy records can be divided in to the main activities of identification of cattle, breeding records, milk production records, feeding and health records (Risstrom, 1999).

The main purpose of the records is for dairy herd management, breeding and progeny testing. Records of insemination, birth date, sire, dam, calving date, vaccination date, health problems, treatment, milk yield and feeding can help farmers to predict future or preventive needs for health care. They also provide beneficial and relevant information for veterinarians to make correct diagnoses. Therefore, it is best to have well-organized records kept for each animal, with the farms designed to allow for easy interpretation. Smallholder farmers do not seem to pay sufficient attention to keeping good records (Aiumlamai, 1999).

As part of animal husbandry, record keeping is an important means to monitor progress and identify problems in the dairying operation. According to Sastry and Thomas (1981), it is important that accurate records be kept on a dairy farm. Records must be simple and easy to understand in order to be effective.

Culling

Dairy cattle's culling is the act of removing dairy cattle from a herd and replacing them with other cows. Dairy cows can be culled from a herd for production or health reasons. The average annual culling rate describes the percentage of cattle that are culled from a herd annually. Determining the optimal culling rate can be difficult for a producer. If the culling rate is too high, farmers fail to earn an adequate return on their cattle investment. If too low, the farmer forgoes production and genetic improvement (Hadley, Gregg Lewis, 2003). This examines how individual cow and farm characteristics as well as market prices affected the likelihood of a cow being culled.

In general, cow attributes such as age, calving season, breed and production affected culling likelihood. Farm attributes such as size, expansion and whether the farm raised registered dairy cattle also affected culling likelihood. Both the milk to feed price and cull cow to replace heifer price ratio affected culling likelihood (Hadley and Gregg Lewis, 2003).

The traditional approach to culling treats the occurrence of the cull event as something that should be minimized. The terms “voluntary” and “involuntary” have been essentially used to describe culling that occurs by choice, usually for low production, and culling that was unavoidable, typically because of disease, injury or death, respectively. By minimizing the number of involuntary (bad) culls, there is an opportunity to gain control by having a higher proportion of voluntary (good) culls.

2.3.7. Technologies in milk processing

Though there are a few milk-processing plants in Ethiopia, much of the milk produced by rural smallholders is processed at home using the traditional technologies (O’Mahony, 1988). Generally, because of the small amount of milk produced for processing on smallholder farms the technique, which are different from place to place, have remained simple and confined to the household levels for a very long time.

The traditional technologies of milk processing are generally considered to be time consuming and inefficient in terms of milk fat recovery as butter per unit of milk. Moreover, besides low diversity of milk products, the quality of the products is poor and resulting in comparatively short shelf life and a lower price for the milk producer (ILCA, 1992). Clay pot, bottle gourd, hollowed wood vessels, stick-having finger like projection at one end, piece of skin, hide, plastic are the different materials used for milk handling and processing in Ethiopia. Both clay pot and the bottle gourds are used most commonly for souring and churning and wooden vessels are used in Borana area (southern part of Ethiopia).

Small-scale processing unit

In the highlands of Ethiopia, milk produced by smallholders is used for family consumption and the production of butter and a cottage-type cheese. For butter making, milk is collected over a period of three or four days in a clay pot. When the milk has soured and sufficient milk has been collected, the clay pot is shaken back and forth until butter granules are formed. This method of butter manufacture may take from two to three hours, depending on such factors as temperature, the fat content of the milk, the acidity of the milk and the amount of milk in the clay pot. The time taken to make the butter together with the time involved in taking this butter to the market place is a considerable drain on the already limited time of the smallholder, or specifically on that of his wife and family.

To reduce the time for processing the milk into butter and to improve the efficiency of the process ILCA has developed and modified a wooden internal agitator that can be fitted to the usual clay pot used by the smallholder. The use of this internal agitator has been shown to reduce churning time from an average of 139 minutes to an average of 57 minutes (59 churnings) while reducing the fat content of the buttermilk from an average of 1.1% to an average of 0.36% (O'Connor, 1990). The buttermilk remaining after the butter has been separated from the whole milk is used to produce a cottage-type cheese (ayib) by heating the buttermilk and separating the coagulated fat and protein from the whey. The price of ayib is about one-seventh that of butter so the monetary advantage of extracting the maximum amount of fat from the milk and converting it into butter is apparent.

2.3.8. Technologies on milk marketing

In Ethiopia, butter is the predominant traded product, generally consumers in Ethiopia and South Africa demand fresh liquid milk and its marketing is dominated by traditional (the so called 'informal') markets, with only small proportions of total production being marketed through a cold-chain, pasteurized process (the so called 'formal' market). For example, in Ethiopia the proportion of total marketed milk sold formally is very small (Tsehay, 2001); in Tanzania and Uganda it is estimated at <5% (Kurwijila, 2002) and in Kenya it is about 15% (Omore *et al*. 1999). Approximately 30–35% of production is consumed on farm (by the family and calves), with the balance (generally four to six liters) marketed.

In the dominant traditional (or 'informal') markets, the milk may pass straight from the producer to a domestic or institutional consumer, or it may pass through two or more market agents before reaching the consumer (Staal *et al*., 1997; Omiti, 2002). Tsehay (2001) and Kurwijila (2002) have noted the importance of intra-urban dairy production in Ethiopia and Tanzania, which, as for peri-urban systems, shortens the market chain for the fresh milk that is preferred by the majority of consumers. As the majority of those consumers have no access to refrigeration, invariably, the custom is to boil the milk to extend its shelf life (Walshe *et al*., 1991; Kurwijila, 2002; Muriuki, 2002).

As Omiti (2002) has discussed for Kenya, the macro-economic reforms implemented or being implemented in East and South Africa, have increased the competition for marketing functions (such as collection, transportation, processing and distribution/retailing) and have resulted in increased income and employment opportunities, especially for small-scale milk traders (Omiti and Muma, 2000). Many sell <120 liters of milk per day, but this business activity enables them to earn a daily income equal to approximately twice the national average (Omore *et al*., 1999; Staal, 2002), which represents a significant contribution to poverty reduction.

Similar estimates are available for Tanzania (Kurwijila,2002) and presumably are estimable for southern African countries like Malawi and Zimbabwe where there are some indications that enforcement of regulations banning the informal marketing of milk is being relaxed. In the face of these strong informal markets, many governments are having to address how best to ensure fair competition between the 'formal' and 'informal' markets to the benefit of producers and consumers, most of whom are in low-income households (Muriuki 2002; Omiti 2002)

2.4. Importance of technologies to improve milk production

2.4.1. Milk production

Intensification of smallholder dairy production that involves technologies like the uptake of cattle breeds with increased genetic potential for milk production and other complementary inputs increase milk production. Inputs may encompass production of improved forages, purchased feeds, disease control measures, improved management practices and improved record keepings. Milk production has risen rapidly due to the wide spread uptake of intensive dairy production with cross breed or high-grade cows (de Leeuw, 1999). Thus, a change in management and uptake of technologies can contribute a lot towards an efficient and profitable milk production system. This has however, to be linked to milk handing, hygiene, processing, distribution and storage so that the primary producer benefits from the increased demand and product diversification (DeBoer, 1981).

2.4.2. Milk composition

Milk composition is an important parameter used to judge the quality of milk. Milk composition varies considerably among breeds of dairy cattle and among cows within a breed. The widest variation occurs with the fat, followed by protein. Lactose and the ash are the list varying milk components. Genetic, environment and various physiological factors greatly influence the amount and composition of milk that is actually produced. Thus, selective breeding and other technologies that lead towards improved management, feeding and health care can be used to upgrade milk compositional quality.

2.5. Importance of technologies to improve reproductive performance

Reproductive performance is a trait of outstanding importance in dairy cattle enterprises. Size of the calf crop is all-important for herd replacement and the production of milk depends heavily on reproductive activity. Possible genetic improvement in virtually all traits of economic importance is closely tied to reproductive rate. The reproductive performance of cattle in the tropics is generally low. This include poor oestrus signs, high frequency of silent heat, poor fertility, delayed age at puberty and age at first calving, long days open and subsequently long calving interval (Mukessa-Mugerwa, *et al*., 1989). This can be attributed to a number of factors such as poor nutrition, diseases, management, genotype and other environmental factors.

2.5.1. Age at first calving

The mean age at first calving for heifers born on the station was 32.9 months. The ¾ exotic ¼ Arsi grades calved significantly earlier (31.3 months) than all other breed groups; whose individual age at first calving ranged from 33.6 to 35.7 months. It appears that Arsi cattle, when managed well, can express their genetic potential within variable groups (Kiwuwa *et al*., 1983).

2.5.2. Calving interval

Mukasa-Mugerwa *et al.* (1989) referring to the Gobe government ranch in Ethiopia reported that the calving interval for zebu was 620 days. In Ethiopia, it is found that the calving interval in crossbred and zebu cattle was 371 and 421 days, respectively. A strategic management and nutritional supplementation to allow calving to occur during the short rainy season, and early weaning of calves have been recommended to be imperative to improve the reproductive efficiency of zebu cattle in Ethiopia (Mukessa-Mugerwa, *et al*., 1989).

2.5.3. Lactation length

Lactation length refers to the period between calving and drying off. Breed, level of nutrition, parity, suckling, and other management factors affect lactation length. Local zebu breeds were found to have shorter lactation length compared to crossbred dairy cows. Dairy cows on good feeding regime will have longer days in milk compared to those kept under poor feeding regime. Therefore, attempts to increase milk yield through cross breeding, selection, better feeding and improved management will extend lactation length.

The mean lactation length of Arsi and zebu was 271 and 303 days respectively. On the other hand, the lactation length of crossbreed was 334 and greater which varies with the blood level of crosses (Kiwuwa *et al*., 1983).

2.6. Benefits of improving smallholder dairy production

Smallholder production systems show low outputs of milk per animal. When analyzed on a cost benefit basis, the use of by-products or other waste as feed, and multiple outputs such as draught and meat production are seen to raise the efficiency of smallholder production systems above those of dairying monocultures. In addition, feeding technologies now allow increases in milk production by matching nutrition to physiological state, age, and management of draught requirements (Zerbini and Gebre-wold, 1999).

Applications of current technologies will allow increases in production and efficiency of milk production by better understanding the nutrient requirements for milk production in addition to those for growth and draft purposes. In general, intensification is understood to increase in efficiency for a unit of a given resource. For advisors and researchers of crop-livestock or pasture –based livestock production, the term is often integrated as increasing productivity per unit of land, usually associated with in increase in stocking rate.

The range of economic benefits from smallholder dairying yet to be universally acknowledged in national planning and socio-economic analyses includes year round engagement of rural and peri-urban labor, utilization of agricultural and other by-products, integration with cropping systems management, conversion of by-products to organic manure for application to crops, provision of nutritious and hygienic food for children.

There are also other benefits such as production of meat from male calves and older cows, reducing the cost of production of meat for traditional markets in circumstances of rising costs as draught power declines as the primary, bovine product, a basis for rural and peri-urban industrial development through milk factories (Falvey, 1999).

Abdinasir, (2000) in Arsi zone showed that forage cultivation, bucket feeding and pasture fencing were the least uptake technologies with uptake rate of 40%. The level of uptake of Artificial Insemination was 46%. The highest uptake rates of 60% were for cowshed and concentrate feeding. Yield could be increased though intensive application of new technologies. Among the most widely emphasized technological factors that help in raising productivity substantially is the use of inputs and methods. Nonetheless, sustainable increase in productivity cannot be attained unless these are accompanied by complementary institutional arrangements like access to credit, extension services and marketing. In recent years, smallholder dairy technologies consisting of crossbred cows, improved feed and improved management practices have been introduced in some parts of the highlands of Ethiopia (Ahmed *et al.*, 2006).

2.7. Constraints of technology uptake

The implementation of new agricultural technologies has become a driving force for management change on smallholder farms. Identifying technologies and management practices could enhance the sustainability of agricultural production, as well as constraints to their uptake, is therefore an important element in attaining sustainable smallholder farming systems. Economic viability is a fundamental condition for the wide spread uptake of technologies and management practices that will help to achieve the goal of sustainable agriculture in general, and dairy in particular. Studies on the factors that influence uptake of agricultural technologies often focus on household resource endowments, characteristics of the household head, location of the household, the nature and extent of information provided before uptake, and characteristics of the technology (Feder *et al*., 1985).

Regarding household resource endowments, it was found that initial costs of technologies determine uptake decisions especially in resource poor farmers. If farmers are resource poor and access to capital is limited, profitable technologies might not be adopted if they require a high capital outlay (Nicholson *et al.*, 1999).

Characteristics of the household head involve variables such as age, level of education, off-farm job and others. Regarding age, as per one study conducted in smallholder dairy farmers in Kenya, the probability of uptake decreases with increasing age of the household head. Older farmers were, therefore, likely to be more reluctant to uptake new technologies or practices. Location of the household involves distance to road and markets so that a household could be able to sell his outputs, at least at current levels of production (Nicholson *et al.*, 1999; Tolera, 2007).

The nature, extent and source of information provided was also found to be a factor that influences uptake decision. The Kenyan experience shows that information used by smallholder farmers to make uptake decision was sought primarily from government/project source and neighborhoods already owing the technology (Nicholson *et al*., 1999; Tolera, 2007).

Characteristics of the technology refer to risk characteristics, complexity and the relative profitability of the technology. The risky production environment can explain the high influence of relative risk on uptake. As an example, the risk of losing an animal due to diseases has been identified as constraining the uptake of smallholder dairy production in Kenya. The profitability of a technology compared to the traditional way of doing things, is also an overriding factor in farmer's decision-making. Technologies on the other hand differ in their relative management complexity. Complexity is high when a farmer has to carry out many activities to establish and run a technology. Technologies with higher relative complexity diffuse more slowly than others diffuse and will finally reach a lower ceiling of uptake (Nicholson *et al*., 1999; Tolera, 2007).

3. MATERIALS AND METHODS

3.1. The Study Area

The study was conducted from September 2007 to May 2008 in Dejen "woreda", which is 210 km north of Addis Ababa, in Amhara Regional State. Dejen is bordered on the south by Abay River, which separates it from Oromia Region, on the west by Awabel, on the North West by Enarj Enawga, on the north by Enemay and on the east by Shebel Berenta. The "woreda" has about 25,398 hectares area coverage, which is divided into three agro-ecological zones namely dega (41%) woyena-dega (31%) and kola (28%). According to the topographical classification, the area also has 49.3%, 38.8% and 11.83% of mountainous, plain, and valley respectively. The area is situated at latitude of $10^{0}10^{''}$ N and longitude of $38^{0}09^{''}$ E with an altitude of minimum of 1080 meters and maximum of 2576 meters above sea level (DARDO, 2007).

The average minimum and maximum annual temperature is 18^{0}C and 30^{0}C respectively. The annual mean rainfall is 954.6 mm. The rainfall has bimodal distribution with long and short rainy seasons. Based on CSA (2006), this "woreda" has an estimated total population of 121,296 of whom 62,630 were females and 58,666 were males; 15,483 or 12.76% of its population are urban dwellers.

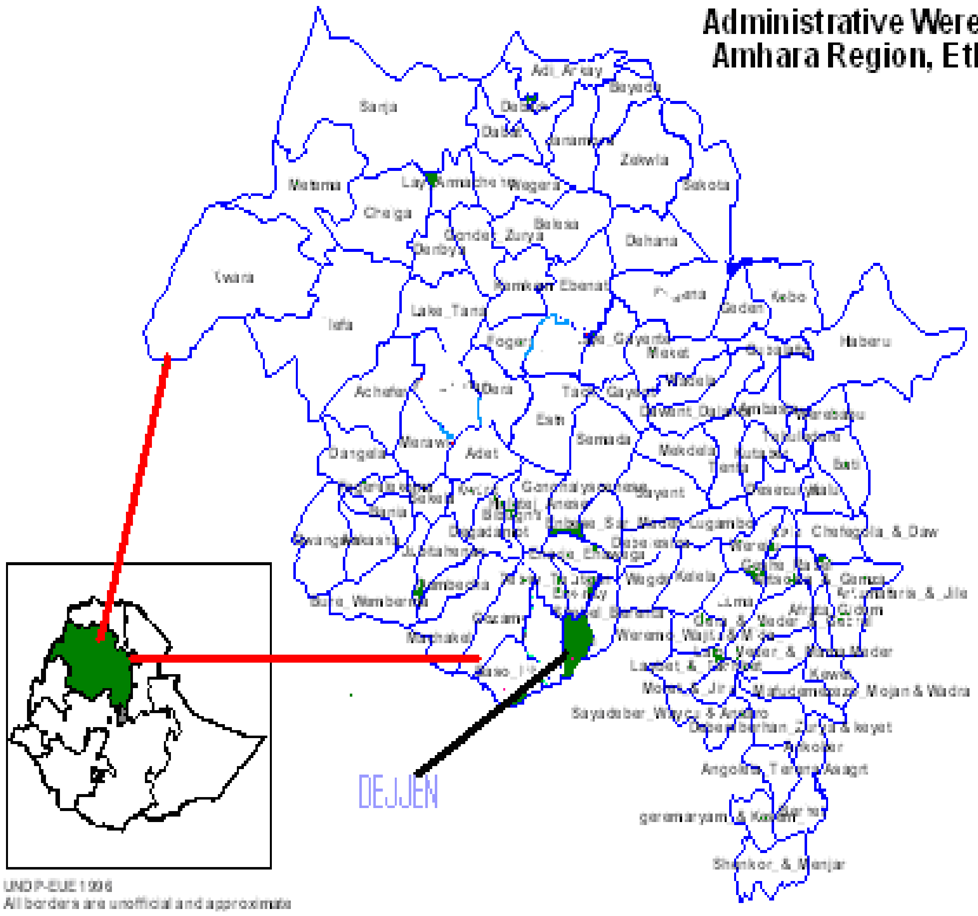


Figure 1: Administrative “woredas” of Amhara Region, Ethiopia
Source: BoFED (2006)

3.2. Study population

The sampling units for the study were smallholder farmers from the high land parts of the “woreda” that were identified as milk shed areas. The “woreda” has totally 21,864 households in 23 peasant associations (PAs). Among those only six PAs, which were known to be milk shed areas, were incorporated in the study. They contain 6,271 households. Almost all of them practice mixed farming system.

3.2.1. Sample size determination and sampling procedure

Sample size of the study was estimated based on the following formula at 90% confidence level and 10% confidence interval (Thrusfield, M. 2005).

$$n = P_{exp} (1 - P_{exp}) Z^2 / (SE)^2$$

Where,

n = sample size

SE = standard error of the population (5%)

p = proportion of the population possessing the attribute (0.5 was used as p value).

q = 1-p

Z = tabular value (1.65 at 90% CL)

Totally, 272 (240 for questionnaire interview and 32 for group discussion) smallholder dairy farm households were included in this study. Systematical random sampling method was used to identify and give equal opportunity for each farmer from each PAs according to the proportion of the population (Table 1). The list of farmers available at "woreda" Agriculture and Rural Development Office was used for the systematical random sampling.

Table 1: Study participants' distribution for interview in Dejen "woreda" in 2007/2008(N = 240 smallholder farmers).

"woreda"	Sampled PAs	Total No.HHs	Sample size	Percentage (%)
	Yetenora	1881	72	30
	Koncher	811	31	12
	Enajema	499	19	8
Dejen	Shemeshengo	1254	48	20
	Zemeten	912	35	15
	Tirch and Jeba	914	35	15
	Total	6271	240	100

Sources: Data obtained from DARDO (2007)

PAs = Peasant Associations, No. HHs = Number of households

3.3. Methods of Data Collection

3.3.1. Questionnaire survey

Active data were collected by way of a cross-sectional questionnaire survey, farm inspection and participatory appraisal (PA) methods. The questionnaire was semi-structured type. It was pre-tested and adjusted prior to its full administration. Three interviewers who speak the same language (Amharic) with the participant smallholder farmers carried out the interview part. Prior to the interview, the purpose of the questionnaire was thoroughly explained to interviewees.

The questionnaire was focusing on demographic characteristics of smallholders, livestock herd size, land use patterns, husbandry practices, dairy production and processing, technology uptakes and constraints.

3.3.2. Farm inspection

One time farm inspection was practiced to assess the housing conditions, feeding practices, milking practices, and available records. The housing condition was qualified as poor when there is bad smell, feed trough and gutter (for waste drainage) were dirty, animals flank, udder and belly were soiled. The housing condition was qualified as good when none of the above indicated defects was observed.

3.3.3. Participatory Rural Appraisal (PRA)

The PRA method used was the “before” and “after” proportional piling tool (Catley, 1999). A sample checklist, serving as a guide and consisting of the main points for the PRA interviews was prepared, pre-tested and adjusted accordingly prior to full implementation. The time-series approach was used to define the “before” and “after” time frame (Kirsopp-Reed, 1994; Catley, 1999). Therefore, the reference time was the 1985 E .C. that was the starting time of SDDP (Smallholder Dairy Development Project) dairy production development technology transfer in the “woreda”.

There were a total of six PRA groups and each group had 6 members consisting of different social segments. All indicators for a particular parameter were written in the local language on pieces of papers, each paper bearing one indicator. The papers were then placed separately on the ground. Then the informants were asked to divide a pile of 100 maize seeds among the indicators according to their prioritization, to score the “before” situation. Throughout the interviews maize seeds were used for scoring, as these are common in the study areas and “visible” to the informants and easy to handle. Factor change method was used to compute the scores attributed for the "before” and “after" periods. The difference between the scores, of the "before” and “after" periods were divided by the “before” value to obtain “Factor Change”. “Factor Change” value indicated both the direction and magnitude of the changes. A positive factor change (FC) for milk production indicated an increased quantity of milk compared to the before situation. However, a positive FC for diseases indicated increase in disease and, thus, no improvement.

A literate informant in the group was asked to read out these indicators from time to time to recall as they discuss and score. During the scoring of the “after” situation the informants are free to increase, decrease or leave the “before” pile of maize seeds of an indicator, according to their perception for the “after” situation. The informants were also allowed to rearrange the piles until they all arrived at an agreeable result.

3.3.4. Secondary Data Collection

The supplementary or a retrospective data was also gathered from reports and records of “woreda” Agriculture and Rural Development Office, Zone and Regional and other related sectors.

3.4. Data Storage and Statistical Analysis

The data collected from the study area entered into the database management software in Microsoft Excel 2003 (Microsoft Corp) and analyzed by the Statistical package for Social Sciences (SPSS release 15, 2006) statistical computer software program.

Descriptive statistics like frequency distribution were used to describe the demographic characteristics in the study area. Computation of ratios and percentages were performed in

Microsoft Excel 2003 (Microsoft Corp). Means, standard deviation, significance differences, associations and correlations were analysed by using Statistical Package for Social Sciences computer soft ware program (SPSS release 15, 2006).

4. RESULTS

4.1. Results of questionnaire survey and farm visit

4.1.1. Demographic characteristics

Table 2 illustrates the demographic characteristics of the sampled households. The average family size of the study population was 5.38 with range of 1 to 11 persons per family. The male to female household heads' ratio was found to be 8:2. Thirty five percent of the households were illiterate. Sixty-five percent of the respondents were able to, at least, read. Education has a significant ($P< 0.05$) positive impact on both number of cattle and average daily milk yield. The farming experience of the households was ranging from 1 to 62 years and the majority (67.1%) had more than 20 years of farming experience. 46% of the respondent farmers were living within 10 kilometers radius of the district town (site for technology dissemination) while the rest were residing beyond this distances. Large majority of the households (85%) owned less than 2 hectares of land. Herd size was increasing with farming experience.

Table 2: Demographic characteristics of smallholder farmers in Dejen “woreda” (N = 240 households, 2007-2008).

Factors and categories	No.of HHs	Mean number of cattle	Mean number of local cows	Mean number of crossbred cows	AMY/d/C (lit)
Sex (of HH head)		**	NS	*	NS
Male	191	5.74(2.66)	1.29(0.83)	0.42(0.73)	3.08(3.14)
Female	49	4.20(2.05)	1.35(0.83)	0.18(0.49)	2.29(2.97)
Age (of HH head)		NS	**	NS	NS
≤ 30 yrs	25	4.38(2.07)	0.86(0.52)	0.31(0.60)	3.16(3.55)
31-40yrs	54	5.24(2.20)	1.14(0.64)	0.28(0.64)	2.80(3.17)
41-50yrs	74	5.73(2.72)	1.20(0.79)	0.46(0.76)	3.15(3.29)
>51yrs	87	5.63(2.84)	1.63(0.92)	0.37(0.68)	2.71(2.79)
Educational level		*	NS	NS	*
Illiterate	85	4.72(2.64)	1.32(0.68)	0.26(0.64)	2.32(2.82)
Read only	65	5.71(2.40)	1.49(0.94)	0.35(0.62)	2.75(2.82)
Elementary	62	5.92(2.75)	1.18(0.88)	0.44(0.74)	3.26(3.26)
Junior and above	28	5.86(2.35)	1.11(0.79)	0.61(0.83)	4.39(3.81)
Family size		**	NS	**	NS
1-3	42	4.02(2.28)	1.05(0.66)	0.24(0.53)	2.39(2.97)
4-6	129	5.33(2.25)	1.32(0.82)	0.30(0.61)	2.81(3.10)
≥ 7	69	6.48(3.00)	1.43(0.90)	0.58(0.86)	3.45(3.19)
Farming experience		*	*	NS	NS
≤ 10yrs	29	4.38(2.08)	0.86(0.52)	0.31(0.60)	3.16(3.55)
11-20yrs	50	5.24(2.20)	1.14(0.64)	0.28(0.64)	2.80(3.17)
≥ 21yrs	161	5.68(2.78)	1.43(0.89)	0.41(0.72)	2.91(3.03)
Distance		NS	NS	*	**
≤ 10kms	110	5.48(2.22)	1.35(0.87)	0.46(0.71)	3.63(3.37)
> 10kms	130	5.38(2.92)	1.26(0.78)	0.29(0.66)	2.32(2.74)
Land holding		**	NS	NS	NS
≤ 1 ha	104	5.09(2.13)	1.26(0.79)	0.37(0.64)	3.02(2.86)
1 - 2ha	101	5.32(2.54)	1.26(0.80)	0.35(0.66)	2.82(3.29)
≥ 2 ha	35	6.77(3.63)	1.57(0.98)	0.46(0.92)	2.92(3.39)

*: Significant at P< 0.05; **: Significant at P < 0.01; NS: Non-significant;

HHs: Households; AMY/d/C: Average Milk Yield per day per Cow (liter)

Numbers in bracts show Standard Deviation

4.1.2. Individual landholding (ha) and use pattern

The average landholding per household was 1.41± 0.69 hectare. The land use pattern in the study area also showed that 98.5% of the land was used for crop production. Almost all the remaining percentage of the land was used for forage development. Grazing land and forest coverage was very minimal than other uses.

Table 3: Summary of individual landholding characteristics of smallholder farmers in Dejen "woreda" (N = 240 households, 2007-2008)

Parameters	Mean	SD	t-value	95%CI
Family size	5.38	1.96	42.4	5.13-5.63
Total land holding (ha)	1.41	0.69	31.8	1.32-1.50
Land used for crop production	1.3924	0.68	31.8	1.31-1.48
Land used for forage dev.	0.0146	0.016	4.9	0.01- 0.02

4.1.3. Livestock herd size and cattle herd composition

The average livestock number of the sampled farmers was described in Table 4. The average livestock holding per household was 11.28 animals or 5.01 TLU. Cattle were the largest in number and represent on the average 49.5% (4.14 TLU) of the total. Horses and goats were the least numbered ones, which represented 0.075 and 0.025 TLU respectively.

Table 4: Livestock herd size per household in smallholder farmers in Dejen "woreda" (N = 240 households, 2007-2008).

Livestock type	No. of animals	No. of TLU	No. of TLU per HHs
Cattle	1340	999	4.14
Horse	23	18	0.075
Donkeys	272	98	0.40
Sheep	1009	91	0.37
Goats	65	6	0.025
Total sum	2709	1212	5.01

TLU: Tropical Livestock Unit (see Annex 1 for conversion values)

Cows on the average represented 30.3% of the cattle herd size of which the local cows' number was the highest. Eighty percent of all cows present in the study population were local breeds. In crossbreed cattle group, cows (34.3%) also dominate in number. Crossbred oxen (2.9%) were the least numbered ones. The overall proportion of cows of cross breed in the cattle herd was 6.0%. The breed ratio of local to crossbred cows was 1: 0.25.

Table 5: Cattle herd composition in smallholder farmers in Dejen "woreda" (N = 240 households, 2007-2008).

Cattle type	Breed type		Total	Breed ratio	95% CI	
	Local	Crossbreed			local	crossbreed
Cows	1.46(0.86)	0.36 (0.69)	1.82	1:0.25	1.35-1.57	0.28-0.46
Heifers	0.51(0.71)	0.21(0.50)	0.72	1:0.38	0.43-0.61	0.15-0.28
Bulls	0.36(0.66)	0.10(0.33)	0.46	1:0.28	0.28-0.45	0.05-0.14
Oxen	1.30(1.13)	0.03(0.02)	1.33	1:0.02	1.12-1.41	0.00-0.06
Calves	0.92(0.79)	0.35(0.25)	1.27	1:0.41	0.82-1.02	0.27-0.43
Total	4.55(4.15)	1.05(1.79)	6.00	5:1.34	4.00-5.12	0.75-1.37

Numbers in the brackets indicate standard deviation

4.1.4. Dairy cattle rearing objectives

Figure 2 illustrates different purposes of cattle rearing in the study area. Milk for family utilization, income from milk sale, draught power, manure and to optimally use family labor were the identified reasons for cattle rearing in a descending order of importance. Milk for family utilization was indicated as primary reason of rearing cattle by 68.4 % of the participant households. Income from milk sale was mentioned by 48 % of the households as first major reason of raising cattle. While twenty-five percent of the interviewed farmers responded that getting draught power through dairy cattle rearing was another objective. Thirteen percent of the respondents also mentioned that manure was one of the reasons for keeping dairy cattle. Lastly, as a means of utilizing the available labor resources was mentioned another reason for keeping dairy cattle in the study area.

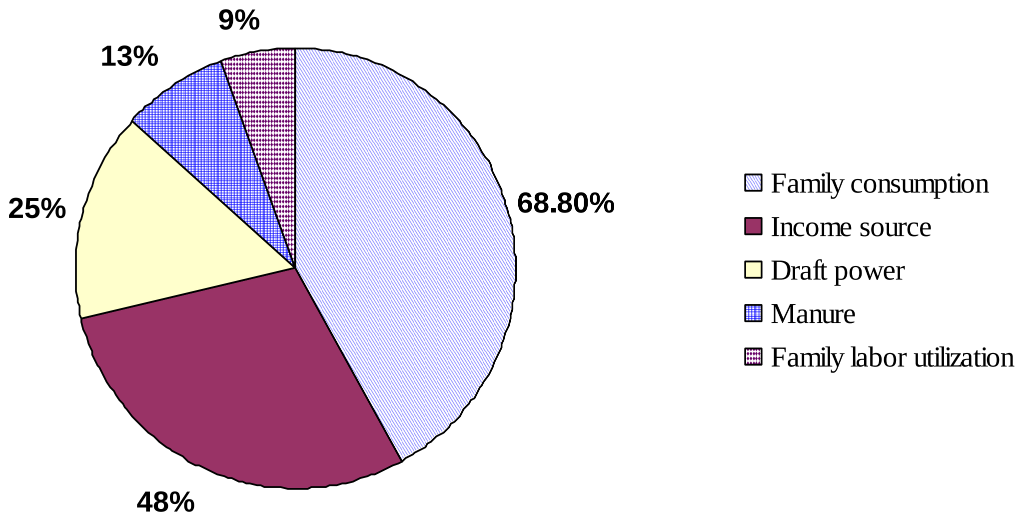


Figure 2: Cattle rearing objectives of smallholder farmers in Dejen “woreda”.

4.1.5. Cattle housing condition

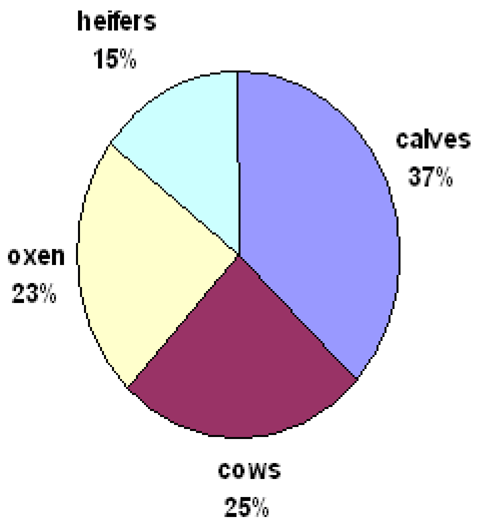
Table 6 shows different cattle housing condition in the study area. It was observed that in 61.3% of the cases people and their animals shared the same house to live. The roofs of the buildings were constructed from different materials such as CIS (Corrugated Iron Sheet), thatch and plastic in a decreasing order of frequency. Different flooring types like soil (41.3%), stone layer (57.1%), and slated (1.2%) were observed. The hygienic conditions of the houses were found good in half of the farms.

Table 6: Summary of dairy cattle housing condition of smallholder farmers in Dejen "woreda" (N = 240 households, 2007-2008).

Parameters	Frequency	Percentage (%)
Types Housing condition		
With the family (communal)	147	61.3
Separate house	73	30.4
Simple enclosure	20	8.3
Roof		
CIS	196	81.6
Thatch	21	8.8
Plastic	3	1.3
Others	20	8.3
Floor		
Soil	99	41.3
Stone layer	138	57.5
Slated and paved	3	1.2
Neatness		
Good	119	49.6
Poor	121	50.5

4.1.6. Cattle health conditions

Two-hundred fifty-two (18.8%) cattle (93 calves, 63 cows, 59 oxen and 37 heifers) died from the total in the study year. Disease, mechanical injury, feed shortage and predators were the major causes for animal death in the decreasing order of their severity as shown in figure 3 & 4.



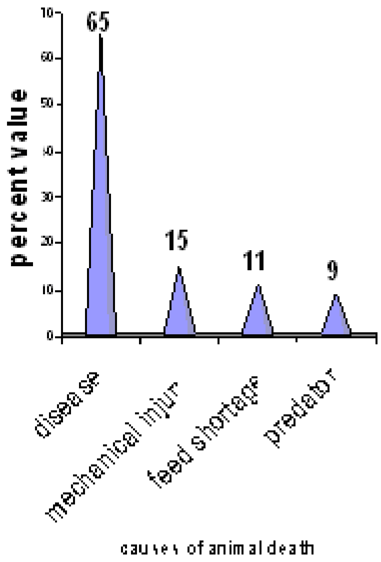


Figure 3: Death incidences in different age and sex groups of cattle during 2000 E .C. in Dejen “woreda”

Figure 4: Factors incriminated cattle deaths during 2000 E. C. in Dejen “woreda”

Blackleg, bloating, anthrax, Lumpy Skin Disease (LSD), fasciolosis, lungworm disease and *Moraxella bovis* (eye disease) were identified as the most important diseases of cattle in the descending order of their importance. 47.9% and 10.4% households used their local knowledge for ecto- and endo- parasite treatment respectively. Meanwhile 59.6% and 98.8% used modern ecto- and endo- parasite treatment respectively. Ninety-eight percent of the respondents used animal vaccination technology, which was periodically delivered by WARDO (“woreda” Agricultural and Rural Development Office) for the stakeholders.

4.1.7. Cattle feeds and feeding systems

The study also revealed that almost all smallholder farmers used a grazing land, crop residues and aftermath as main sources of feed for their animal. 81.7% and 1.7% of interviewed households utilized hay and silage respectively. 36.3% of the respondents provided Nug cake (Fagulo) for their cattle. Provision of urea treated straw (UTS), concentrate feed and grain (maize) practiced by 2.51%, 32.1%and 15.0% farms respectively.

Different forage species have been developed in the study area. Sesbania was the forage species that was practiced by 94 (39.2%) households followed by Napier grass 92 (38.3%). Vetch/oat mix and fodder beet also practiced next to Napper grass in the same order.

Some 46.0% small holders were stall-feeding their cows particularly during crop production season and/or during late pregnancy or early lactation stages of production. Almost all smallholders used free grazing and a very small proportion of them (1.3%) used rotational grazing system.

4.1.8. Shares of responsibilities of family members of the routine dairy farm activities

The different dairy production activities practiced in the study area include livestock purchasing and selling, herding, watering, stall feeding, sick animal care, milking, making dairy products, dairy product selling, barn cleaning and cattle washing. Table 7 gives the details of distribution of these activities among family members. Husband and wife appeared to have comparable overall work share (39.9% for husband and 39.16% for wife) although there was clear variations in specific areas of activities. Husband's highest work share is represented in livestock purchase and sale activities while those of wives were in barn cleaning and making dairy products. Hired labor is primarily used for herding activities. Generally, children, in particular, girls have a considerable role (around 25% share) in barn cleaning, cattle herding, watering and making dairy products

Table 7: Shares of responsibilities of family members of the routine dairy farm activities in Dejen "woreda" (N = 240 households, 2007-2008).

Activities	Husband (%)	Wife (%)	Children (%)	Hired (%)
Livestock purchasing & selling	79.1	18.9	0.8	1.2
Dairy product selling	29.2	58.8	11.6	0.4
Milking	54.6	38.5	3.9	1.2
Making dairy products	17.5	68.2	13.6	0.7
Herding	25	16.5	25.8	32.7
Stall feeding	43.1	34.8	21.3	0.8
Watering	31.8	34.2	24.7	9.3
Sick animal care	58.8	34.8	4.0	2.4
Barn cleaning	6.5	69.3	22.5	1.7
Cattle washing	52.9	17.6	23.5	6.0
Over all average	**39.9**	**39.16**	**15.17**	**5.64**

4.1.9. Major constraints of dairy production

Table 8 presents the major constraints of dairy production in the study area. Among those feed shortage, shortage of grazing land and financial scarcity were the top three problems. Management problem, water scarcity, labor scarcity, animal health problem and improved breed problem also were identified as 4 to 8 ranked constraints respectively. Even the price of milk and lack of credit also become the bottleneck of dairy production in the study area with the least degree.

Table 8: Major Constraints of dairy production of smallholder farmers in Dejen “woreda” (N = 240 households, 2007-2008)

Constraints	Frequency	Percentage (%)	Rank
Feed shortage	153	63.75	1
Shortage of grazing land	140	58.33	2
Financial problem	73	30.42	3
Management problem	66	27.50	4
Water scarcity	62	25.83	5
Labor scarcity	61	25.42	6
Animal health problem	50	20.83	7
Improved breed problem	45	18.75	8
Lack of credit	7	2.92	10
Low milk price	7	2.92	10

4.1.10. Summary of dairy technologies uptake

Table 9 illustrates list of technologies and levels of their use in the study areas. Totally, 25 dairy technologies with different uptake levels were observed. Technologies that were widely used in the study areas (more than 81% uptake levels) were modern endo-parasite treatment, vaccination, estrous detection and haymaking. Technologies such as pregnancy test, modern ecto-parasite treatment, total and partial stall feeding, crossbreed cattle, forage development, feed supplement, artificial insemination (AI), separate type of house, bull station, udder washing and record keeping were found in declining order at intermediate uptake level. While modern milk processing, urea treated straw (UTS) and silage were the least practiced ones with in a range of 1.7 to 14 per cent uptake levels. Rotational grazing and fodder beet development also introduced in the area but they were practiced with a minimal uptake rates less than one percent. In general, all the respondent farmers were users of at least two dairy technologies.

Table 9: Summary of dairy technologies practiced by smallholder farmers in Dejen "woreda" (N = 240 households, 2007-2008).

Dairy technologies	Frequency	Percentage (%)
Forage development		
Sesbania	94	39.2
Napier grass	92	38.3
Vetch & oat mixed	49	20.4
Forage treatment(Urea treated straw (UTS))	5	2.1
Feeding system		
Total and partial Stall feeding	112	46.6
Rotational grazing	2	0.8
Feed conservation methods		
Hay making	196	81.7
Silage	4	1.7
Supplementary feeding		
Commercial feed (concentrate)	77	32.1
Nug cake (Fagulo)	87	36.3
Grain	36	15.0
Management		
Modern Castration	122	50.8
Record keeping	37	15.4
Udder washing	68	28.3
Animal Breeding		
Artificial insemination	75	31.3
Bull station	37	15.4
AI & Bull station	20	8.3
Cross breed utilization	101	42.1
Reproductive technologies		
Estrous detection	205	85.4
Pregnancy test	153	63.8
Modern Milk processing (through milk cooperatives)	34	14.2
Animal health care		
Vaccination	235	97.9
Modern ecto- parasite treatment	143	59.6
Modern endo- parasite treatment	237	98.8
Separate type of house	73	30.4

4.1.11. Major constraints of dairy technologies uptake

This survey study showed that dairy technologies uptake in the study area was influenced by different factors. Figure 5 illustrates the responses of smallholder farmers regarding constraints of technologies uptake. Forty-seven percent of the respondent farmers mentioned that lack of feed was the most pronounced problem followed unavailability of technologies like improved cattle breed, forage seed, AI and veterinary services. Insufficient extension work (lack of training), financial problem, land scarcity, cost of inputs, lack of labor and low price of milk were also indicated in declining order of importance as constraints for technology uptake.

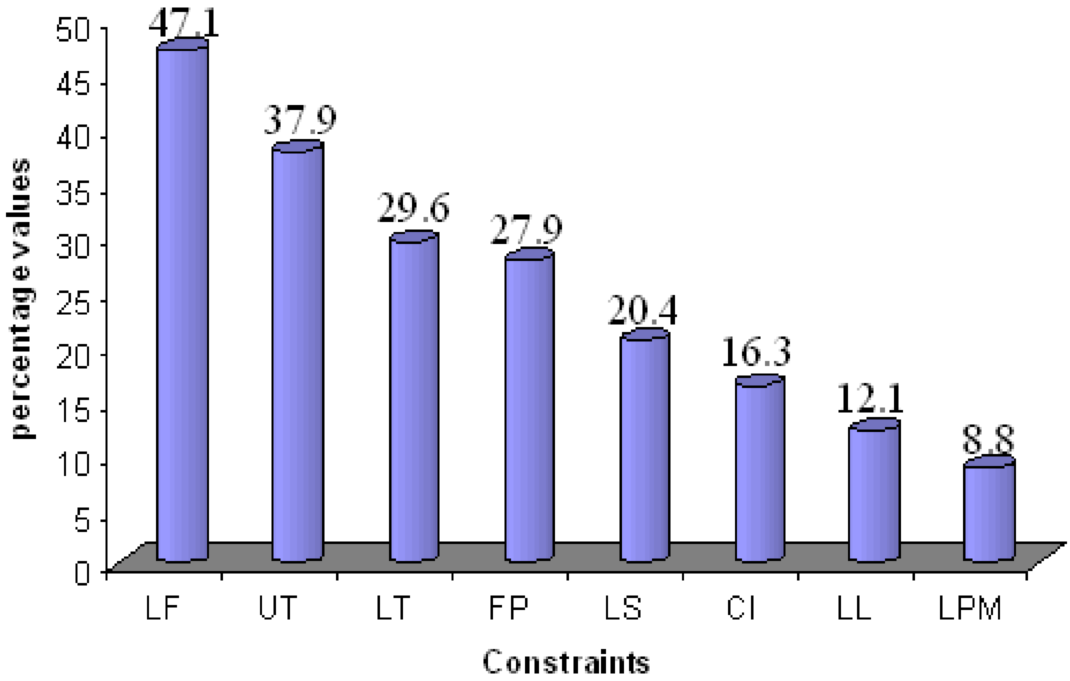


Figure 5: Factors influencing dairy technology uptake in smallholder farmers in Dejen "woreda" (N = 240 households, 2007-2008)

KEY: LF = Lack of Feed; UT = Unavailability of technologies; LT = Lack Training; FP = Finance Problem; LS = Land Scarcity; CI =Cost of Inputs; LL = Lack of Labor; LPM = Low Price of Milk.

4.1.12. Association of technologies uptake with different demographic characteristics of smallholders

Table 10 shows the associations of different demographic characteristics with technologies uptakes. Male headed households adopted significantly (P<0.001) higher number of technologies than female headed households. In groups of households that adopted less or equal to 5 technologies (n= 36), 45 % (n = 17) were female. (n = 131) were uptake 6-10 technologies and the ratio of female was 18.3 % (n = 24). While 30 % (n = 73) uptake greater than 10 dairy technologies of which 11.3 % (n = 8) were female respondents.

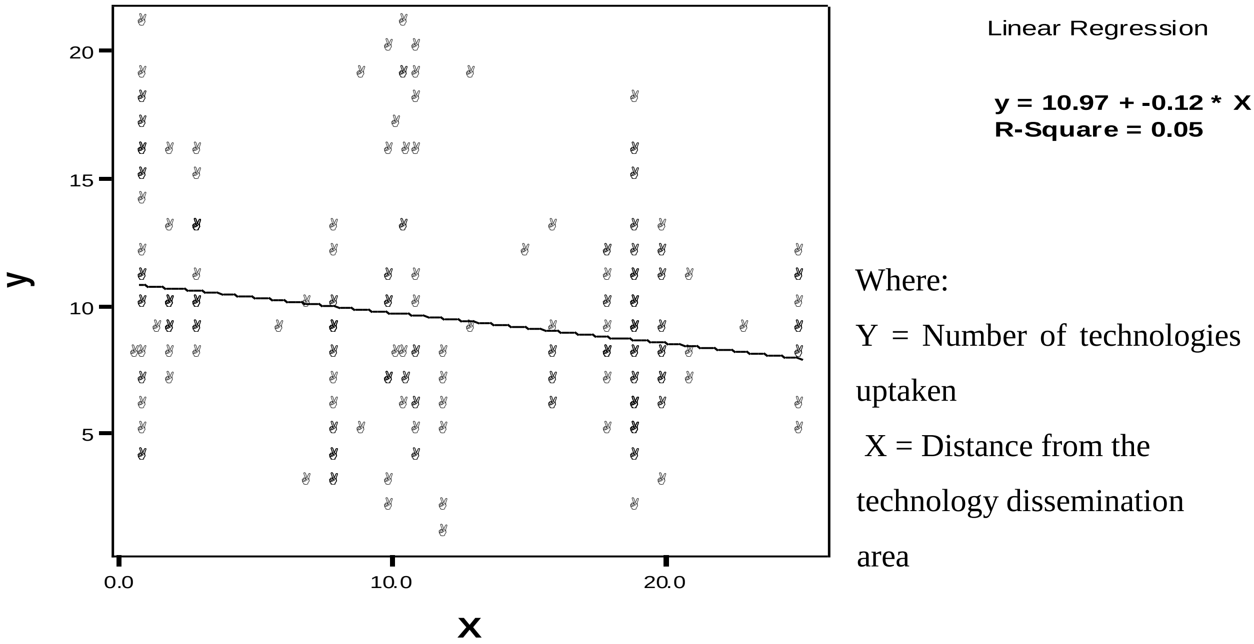
Family size was another characteristics that was closely associated with technology uptake; the larger the family size the higher the number of technologies adopted (P<0.01). Number of technologies adopted were also significantly (P<0.01) increased with the level of education. Distance from technologies supply site was inversely correlated with technology uptake. The households that lived within 10 kilometers radius from technology dissemination source adopted more number of dairy technologies (P<0.05) than those living beyond that distance

Table 10: Association of technologies uptakes with different demographic characteristics of smallholder farmers (N = 240 households, 2007-2008)

Factors	Frequency	Mean of tech.used	SD	95% CI	df	P-value
Sex(of HH head)						
Male	191(79.6)	9.99	3.96	9.42-10.55	1	0.001
Female	49(20.4)	7.88	4.22	6.67-9.09		
Age(of HH head)						
< 30 yrs	25(10.4)	9.31	3.516	7.97-10.65	3	0.195
31-40yrs	54(22.5)	10.16	4.032	9.01-11.31		
41-50yrs	74(30.8)	10.05	4.514	9.01-11.31		
>51yrs	87(36.3)	8.87	3.884	8.05-9.70		
Farm experience						
≤ 10yrs	29(12.1)	9.31	3.52	7.97-10.65	2	0.503
11-20yrs	50(20.8)	10.16	4.01	9.01-11.31		
≥ 21yrs	161(67.1)	9.42	4.21	8.76-10.07		
Family size						
1-3	42(17.5)	7.95	3.88	6.74-9.16	2	0.005
4-6	129(53.8)	9.55	3.87	8.88-10.23		
≥ 7	69(28.8)	10.55	4.36	9.50-11.60		
Educational level						
Illiterate	85(35.4)	8.42	4.33	7.49-9.36	3	0.002
Read only	65(27.1)	9.43	3.58	8.54-10.32		
Elementary	62(25.8)	10.40	3.93	9.40-11.40		
Junior and above	28(11.7)	11.43	3.91	9.91-12.94		
Distance						
≤ 10kms	110(45.8)	10.19	4.31	9.38-11.01	1	0.027
> 10kms	130(54.2)	9.02	3.83	8.36-9.69		
Land holding						
≤ 1 ha	104(43.3)	9.56	3.44	8.98-10.32	2	0.340
1 - 2ha	101(42.1)	9.19	4.58	8.28-10.09		
≥ 2 ha	35 (14.6)	10.34	4.35	8.85-11.84		

SD: Standard Deviation; df: degree of freedom; numbers in bracket represents percentage of households

The correlation coefficient between different demographic characteristics and number of technologies uptake also showed that age (r = -0.106), farm experience (r = -0.092) and distance (r = -0.220) were inversely related with the number of technologies uptake whereas, farm size (r = 0.221), educational level (r = 0.269) and land holding (r = 0.109) were positively correlated (Annex-3). Figure 6 further illustrates the above-indicated correlation of technologies uptake with distance of the farms from the technology dissemination site.



Where:
Y = Number of technologies uptaken
X = Distance from the technology dissemination area

Figure 6: Association of distance with technologies uptake in the Dejen “woreda” Smallholder farmers (N = 240 households, 2007 - 2008)

4.1.13. Effect of technologies on milk production and reproductive performance of dairy cows

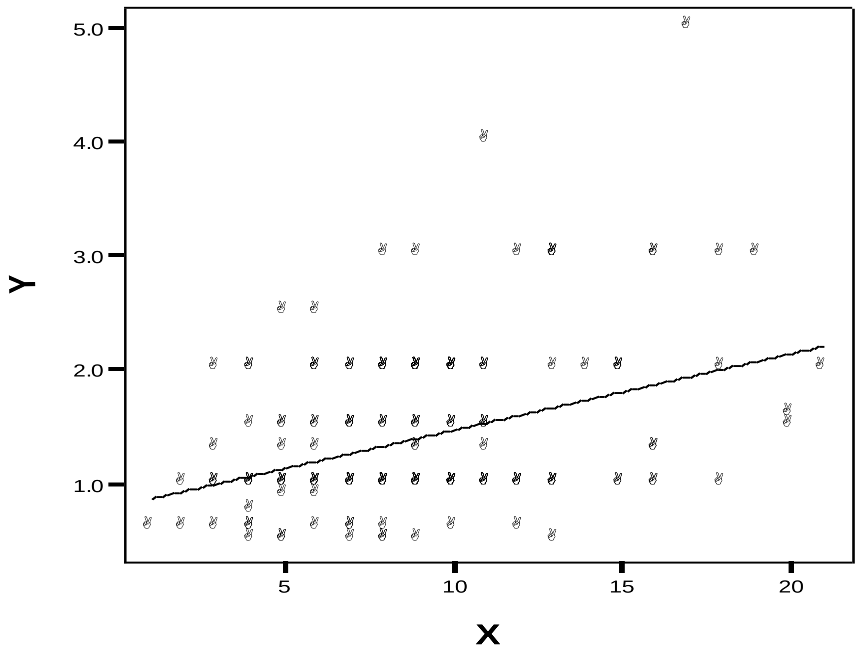
Table 11 describes the effect of genetics (exotic blood) on production and reproductive characteristics of dairy cattle. Age at first calving was 3.99 ±0.99 and 2.73 ± 0.73 for local and crossbreeds respectively, which showed significant difference (P< 0.001). The average daily milk yield of crossbreed cows (6.01± 3.20) was significantly (P< 0.001) higher than local cows (1.46 ± 0.99). The average milk yield per lactation showed a significant difference at P <0.001. Local cows were significantly lower than crossbreed cows in the average milk yield per lactation. There was also a significant difference at P< 0.001 in all mentioned reproductive performance parameters with only exception of average lactation length.

Table 11: Milk production and reproductive performance of local and crossbred dairy cows in smallholder farms in Dejen “woreda” (N = 240 households, 2007-2008)

Parameters	Breed type	Mean	SD	95% CI f	df	P-value
Age at first calving	Local	3.99	0.99	3.85 – 4.12	1	0.000
(years)	Crossbreed	2.73	0.73	2.55 – 2.91		
Average milk	Local	1.46	0.99	1.32 – 1.59	1	0.000
yield (lit/day/cow)	Crossbreed	6.01	3.20	5.21 – 6.80		
Average lactation	Local	8.04	2.36	7.72 – 8.36	1	0.206*
length (months)	Crossbreed	8.43	1.47	8.07 – 8.79		
Average milk yield	Local	338.06	197.91	311.3- 364.8	1	0.000
per lactation (lit)	Crossbreed	1456.69	771.15	1265.6-1647.8		
Calving interval	Local	21.78	8.89	20.58 – 22.98	1	0.000
(months)	Crossbreed	14.02	3.43	13.17 – 14.87		

df: degree of freedom; SD: standard deviation; CI: confidence interval, *: not significant

Other dairy technologies rather than genetic parameter also have positive impact on milk yield of both local and crossbred cows. As shown in Figure 7 and 8 the number of technologies and milk yield have a positive linear relation. Milk yields both in local and crossbreed cows increased with the number of dairy technologies but the rate of increment varies with respect to breed type. In local breed cows, milk production increased by 0.07 times when the number of technologies increased by one unit (R^2 = 0.13). However, in crossbreed cows, milk production increased by 0.38 times when the number of technologies increased by one unit (R^2 = 0.23) which means the rate of increase in crossbreed is five fold than in local breed cows.



Linear Regression

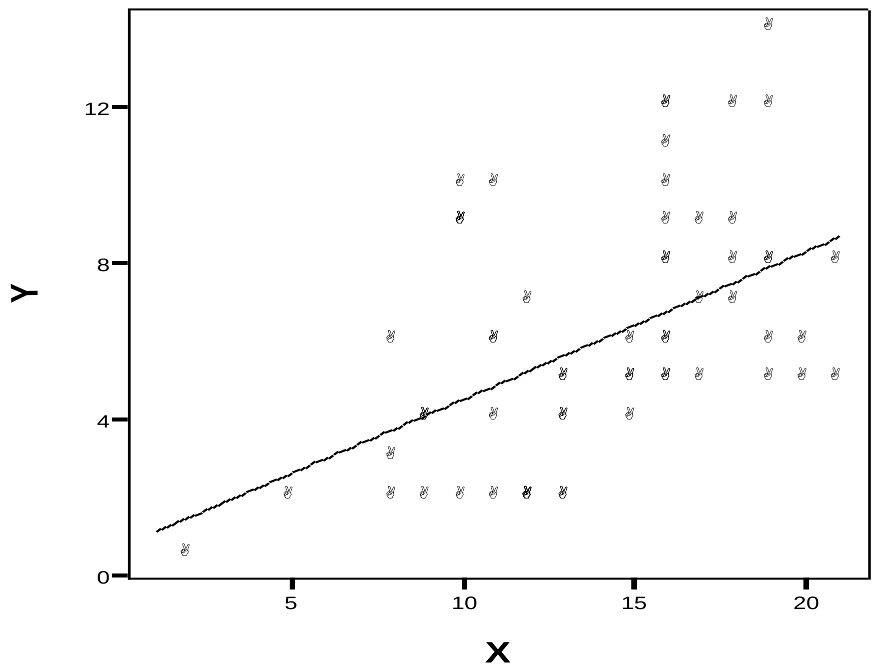
Y = 0.81 + 0.07 * X
R-Square = 0.13

Where:

Y = Average Milk Yield of local cow

X = Number of technologies uptaken

Figure 7: The association of technologies uptake with milk yield on local cow in the Dejen "woreda" Smallholder farmers (N = 240 households, 2007 -2008)



Linear Regression

Y = 0.77 + 0.38 * X
R-Square = 0.23

Where:

Y = Average Milk Yield of Crossbreed

X = Number of technologies uptaken

Figure 8: The association of technologies uptake with milk yield on crossbred cow in the Dejen "woreda" Smallholder farmers (N = 240 households, 2007 -2008)

4.2. Group discussion results

4.2.1. Milk production and its utilization before and after technology transfer in the study area

Based on informant groups discussion, milk production was very small in the "before" situation and changed into five times more production in the "after" situation. The informant groups identified four types of milk use categories and it varies in the "before" and "after" situation. Milk for household consumption was the leading followed by milk for sale in the "before" situation. Similarly, milk for children consumption and milk used for cosmetics purpose also ranked in the same order next to sold milk in the "before" situation as described in Table 12. In the "after" situation, selling of milk became the leading one followed by household consumption.

Milk for sale increased almost 3 times in the "after" situation than in the before. This was due to the establishment of dairy cooperatives, high demand of cash income and increment of milk price than in the previous. In the "before" situation there was no a trend to sell fresh milk in the area but in the "after" situation it is practiced and gradually increased and became 2.30 birr per liter of fresh milk.

Table 12: Milk use categories identified by groups of smallholder farmers using proportional piling method (N = 240 households, 2007-2008)

Milk production and use categories	Group informants(N = 6)	
	Before/after	FC
Milk production	45/226	4.1
Household consumption	100/31	-0.69
Cosmetics use	30/4	-0.85
For sale	80/200	1.5
For children consumption	50/9	-0.81

FC: factor change = (after-before)/before

4.2.2. Disease status in before and after technology transfer situations of the study area

Generally, eight types of disease were identified as the major important ones by group discussion. Among those mastitis, lungworm problem and *Moraxella bovis* were first ranked problems and followed by fasciolosis and ticks at the same order in the "before" situation. Bloating, blackleg, and anthrax were also having significant shares.

In the "after" situation mastitis, lungworm problem, bloating and *Moraxella bovis* increased than in the "before" situation. On the other hand, fasciolosis, blackleg, anthrax and ticks decreased. However, the rate of decrement varies along different diseases. Anthrax and fasciolosis were the first two diseases, which decreased in high rate whereas blackleg was the least (Table 13).

Table 13: Animal disease status identified by groups of smallholder farmers using proportional piling method (N = 240 households, 2007-2008)

Medical (Local) name of diseases	Group informants (N = 6)	
	Before/after situation	FC
Fasciolosis (Kelekelo)	98/20	-0.8
Anthrax (kureba)	56/9	-0.84
Mastitis (yetutebesheta)	100/132	0.24
Lung worm problem(sale)	100/138	0.28
Ticks (mezeger)	95/37	-0.6
Bloating (hodemenfant)	90/129	0.43
Moraxella bovis (eye disesase)	100/128	0.28
Blackleg (worchiga)	75/50	-0.33

FC: factor change= (after-before)/before

4.2.3. Uses of different veterinary services in before and after technology transfer situations of the study area

Different veterinary services have been practiced in the study area. According to the informant groups, there were four types of veterinary services identified which were practiced both in the "before" and "after" situation. Traditional animal treatment and religious healing were highly performed than modern animal treatment and vaccination in the "before" situation but in the "after" situation modern animal treatment and vaccination became five times and three times more than in the "before" situation respectively while traditional animal treatment and religious healing decreased in the "after" situation as indicated in Table 14.

Table 14: Uses of deferent veterinary services identified by smallholder farmers using proportional piling method (N = 240 households, 2007/2008)

Types of veterinary services	Group of informants(N =6)	
	Before/after situation	FC
Modern treatment	54/256	3.7
Traditional treatment	100/34	-0.66
Religious healing	60/11	-0.81
Vaccination	49/147	2.0

FC: factor change = (after-before)/before

5. DISCUSSION

The mean value of family size in the study areas (5.38 persons) was higher than what was reported by CSA (2003) which was 4.5 for the same “woreda”. This difference might be the reflection of the steady growth of the population; the CSA survey was done some six years back. However, our result is comparable to the family size that indicated for the whole country (5.15) by CSA (2006).

Land, which is a key asset, was scarce in the area. The average individual household land holding was 1.41 ha. This result is slightly greater than what was reported by Jayne *et al.* (2003) for the whole country as 1.17 ha per household.

Cattle (4.14 TLU) per household were the most important animals, which constituted 49.5% of the livestock. Cows represented 1.6 TLU of which 1.2 TLU were local breed and 0.4 TLU were crossbred cows. These values differ from what was reported by Abdinasir (2000) in Arsi; cattle, local and crossbreed cows holding per household was 9.53 TLU, 1.58 TLU and 1.31 TLU respectively. Cattle herd size was significantly ($P<0.05$) influenced by different demographic characteristics (sex, educational level, family size, farm experience and landholding).

Female headed dairy farms were only 20.4 % of the total. The average number of cattle in female owned farms (4.2 ± 2.05) was significantly ($P<0.01$) lower than that of male headed dairy farms (5.74 ± 2.65). Local breed and crossbreed cows numbers were also smaller in female owned farms. This result differs from the findings of Mekonnen *et al* (2005) who stated for Addis Ababa area that women owned 38% of smallholder farms and had more cows (median = 3) than men - owned ones. The low technology uptake and less land holdings of female-headed households in the study area might be reasons for low number of cattle.

Husband and wife had comparably larger share of farm activities than other family members did. Milking was mainly done (54%) by husbands. This is different from the findings of Tolera (2007) who stated that females (90.1%) in Selale mostly did milking. Cattle temperament that frightens females and husbands preference to give priority for calf feeding might be possible reasons for low level of participation of females in milking in the study area.

As in the other parts of Ethiopia, in the study area, feeds were not available throughout the year. To mitigate this seasonal feed scarcity, farmers practiced different feed conservation technologies like haymaking (81.7%) and silage making (1.7%). Almost all smallholder farmers used a grazing land, crop residues and aftermath as main sources of feed for their animal. The feed resources used through different feeding systems such as free grazing, rotational grazing and stall-feeding. Free grazing was the predominant feeding system, which was practiced by more than ninety percent of the households in the study area. This result partially coincide with the study conducted by Tuomo (1993) in Selale area of North Shewa zone who reported that grazing natural pasture, hay and crop residues make the basal diet of livestock.

The average milk yields of local and crossbred cows were 1.46 ± 0.99 and 6.01 ± 3.20 liters per day respectively. O'Connor and Zenash (1990) in East Shewa zone reported 2 liters as average daily milk yield of local cows. However, the average daily milk yield of crossbred cows in this study area (6.00lts/day) was in agreement with the finding of the same authors who stated that average daily milk yield of crossbred cows as 6 liters. This implied that intensification of smallholder dairy production that involved technologies like the uptake of cattle breeds with increased genetic potential and other complementary inputs increased milk production. The result also revealed that the number of technologies adopted by smallholder farms and milk yield of cows had a positive linear relationship in both local and crossbreed cows but the rate of increase in milk yield of crossbreed cows is five fold than local cows.

Age at first calving of local and crossbred cows were 3.99 ± 0.99 and 2.73 ± 0.72 years respectively and it was significantly different at $P<0.001$. This result partially supported by Kiwuwa *et al*. (1983) who found that age at first calving for graded Arsi cattle breed was 31.3 months (2.61years). However, in case of local cows the result was not similar and greater than the findings of the same author, which was 32.9 months (2.74years) but supported by the findings of Kelay (2002) who stated that age at first calving of local cows was 53 months(4.4 years). The reason for this difference might be breed difference and research conditions; the previous was done on station while the later was based on farm survey. It was also observed that improved breed utilization reduced the age at first calving

The average lactation length of local (8.04 ± 2.35 months) and crossbred dairy cows (8.43± 1.46 months) did not show significant difference. Abdinasir (2000) at Bilalo and Lemmu reported that average lactation length of crossbred dairy cows were 363.5 days (12 months) and 383.7 days (12.79 months) respectively. The shorter lactation length in the present study may reflect improper management, feed shortage and environmental differences.

The calving interval of local and crossbred were 21.78± 8.88 and 14.02± 3.43 months respectively. This result is in agreement with the findings of Mukassa-Mugerewa *et al.* (1989) for local cows but differs for crossbred calving interval. The authors reported that the calving interval of local cows as 620 days (21 months) and crossbred as 371days (12.36 months).

Totally, twenty-five technologies transferred and practiced in the study area however, the level of uptake were varying among the households. This variation occurs due to demographic characteristics of households and feature of the technologies. Sex, age, level of education, farming experience, family size and distance were important demographic characteristics that favor demand for dairy technologies uptake in the study area. This result in line with the finding of Chantalakhana (1999) who examined about 23 well known animal technologies and stated that the rate of adoption of technologies by small-scale farmers who raised bovine animals in Thailand was different. There was a significant difference at $P<0.001$ between male and female technology uptake.

Male used wider technologies (9.99 ± 3.96) than females 7.88 ± 4.22. This result supported by Tolera (2007) who stated that female groups are less users of dairy technology averaged 9.26±1.90 compared to the male groups averaged 9.95±2.20 in Selale. Illiteracy also considered as a major limitation to technology uptake of the study area. Technologies uptake increases with the increases of educational level of the households. Family size has a positive correlation with the number of technologies uptake while age of households, farm experience and distance have a negative correlation (Annex-3).

Households above 51 years of age used less number of technologies (8.87 ± 3.88) than in the other groups. This result in line with the finding of Nicholson *et al. (*1999) who stated that the probability of technology uptake decreases with increasing age of the household head. Older farmers were, therefore, likely to be more reluctant to adopt new technologies or practices.

The study revealed that shortage of feed, unavailability of technologies, lack of training, finance problem, land scarcity, cost of inputs, lack of labor and low milk price were the major factors that limited technology uptake in decreasing order of their importance. Even though there is variation in the degree of importance, this finding was supported by Tolera (2007) in Selale who stated that land shortage, labor shortage, feed shortage, lack of Govt. assistance, health problems, market problem, lack of credit and cost of crossbred animals were some of the constraints for technology uptake in declining order.

Inadequate supply of quality feed became the most prominent problem for technology uptake in the study area. Feed, usually based on fodder and grass, are not available in sufficient quantities, which could be the result of fluctuating weather conditions. The supplementary feed (concentrate) was also insufficient in the area due to limited availability and high cost. This result is in line with the findings of Kelay (2002) who stated that in Addis Ababa, lack of livestock feed was mentioned as the most important constraint by all the farm scales that is by 92%, 85.7% and 83.3% of the small scale, medium scale and large scale farms, respectively.

Forage development like Sesbania, Napier grass and vetch and oat mixture were comparable practiced technologies in the area while fodder beet was the least used dairy production technology with less than 0.5% uptake level. Although the application was highly influenced due to land scarcity, Sesbania and Napier grass integrated with other dairy technologies played a significant role in the intensification of small dairy production. This finding agrees with Peters and Lascano (2003) who stated that forage and browse legumes play an important role in sustaining livelihoods of small and medium-scale farmers in the tropics, mainly because of their contribution to economic and environmental sustainability

More than 80% of the smallholder farmers used the usual free natural mating, which was highly traditional, with other mating practices. Artificial insemination, bull service, both artificial insemination and bull service were also practiced by 27.9%, 7.5% and 9.2% respectively which were depending on the availability of AI- technician, liquid nitrogen, the ability of estrous detection and the accessibility of healthy crossbred bulls. Because of these problems and ignorance, 22.5% of Artificial insemination and bull service user households are coming back to use free natural mating. This result is in agreement with the findings of Mekonnen *et al.* (2005) around Addis Ababa who found that thirty two percent of smallholders used artificial insemination (AI) and farmers exclusively using natural mating mentioned access problems and/or ignorance as reasons for not benefiting from the artificial insemination scheme.

Forty-two percent of households used crossbreed that showed a significant ($P<0.001$) milk production increase (6.01 ± 3.20) than local breeds (1.46 ± 0.99) in the study area. This finding coincides with the idea of Ahmed *et al*. (2000) who stated that improved dairy technology based on high-yielding crossbred cows and production of improved forages has the potential of increasing milk production of smallholder households for both home consumption and the market.

The participatory appraisal study illustrated that the milk production and its utilization, diseases status and different veterinary service in the “before” and “after” situations of the study area. Milk production became five times greater in the after situation than in the before situation which was resulted from the cumulative effect of different dairy technologies uptake like crossbreed, animal health service and improved feeding system. The gradual increment of milk and butter prices as well as the need of farmers for more cash income resulted in the shifting of milk utilization from household and children consumption to the market products.

The disease status of the area also assessed through the participatory appraisal method and revealed that anthrax, fasciolosis, ticks and blackleg were high before different dairy technologies transferred in the area and become less after the technology uptake. On the other hand mastitis, lungworm problem, bloating and *Moraxella bovis* (eye disease) become high in the after situation than in the before situation. The main reasons for disease intensity in the after situation might be farm intensification, poor management and feed shortage. Smallholder farmers also become aware of veterinary services. They leave the religious healing and other traditional treatment methods and then shifted to the modern animal treatment after certain dairy technologies practiced in the area.

6. CONCLUSION AND RECOMMENDATIONS

Livestock in general and the dairy sector in particular, was found to make considerable contribution to the smallholder farmers. Cattle represented the largest proportion of the livestock population. They were source of milk for family consumption, income from milk sale, draught power, manure and to use the available labor.

Totally, 25 dairy technologies with different uptake level were inventoried. Technologies that were widely used in the study areas (more than 80% uptake level) were modern endo-parasite treatment, vaccination, estrous detection and haymaking. Technologies such as pregnancy test, modern ecto-parasite treatment, total and partial stall feeding, crossbreed cattle, forage development, feed supplement, artificial insemination (AI), separate type of house, bull station, udder washing and record keeping were found in declining order at intermediate uptake level.

The number of technologies adopted by smallholder farms and milk yield of cows had a positive linear relationship in both local and crossbreed cows.

Female-headed households were less technology users, this resulted in small number of cows and less average daily milk yield than what was observed in male-headed households. Education was found to have positive association with technology uptake while distance from technology dispatch center had negative correlation. The households that lived within 10 kilometers radius from technology dissemination source adopted more number of dairy technologies ($P<0.05$) than those living beyond that distance.

However, major constraints like feed shortage (both local and commercial feeds), grazing land scarcity, financial problem, lack of credit and low price of milk (market problem) in the decreasing order of their severity limited the production of the dairy sector.

Even though different dairy technologies were introduced and many smallholder farmers started to use, they are not efficiently practiced in the area due to the above mentioned and other related problems

Having the above-mentioned conclusions, the following points are recommended:

1. Dairy cooperatives could serve as entry point for technology transfer. Thus, encouraging the establishment of new cooperatives and further strengthening the existing ones should be sought.

2. Feeds availability was one of the major limiting factors for technology uptake. The government should invite and encourage private sector to be widely involved in animal feed production and processing.

3. The establishment of a dairy institute, at least at federal level, is strongly recommended. The institute will have a role in providing training to dairy farmers and different level of professionals. It will also do adaptive research of technologies and technology popularization.

4. Credit and saving institutions instead of lending money, if could provide technologies (crossbred, concentrate feed, etc....) in kind form.

5. Further research is needed to determine the impact of dairy technologies on household economy.

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ANNEXES

Annex 1: Conversion factors used to calculate TLU

Livestock type	TLU
Ox/bull	1.10
Cow/local	0.80
Cow/cross	1.20
Heifer	0.50
Calves	0.20
Sheep	0.09
Goat	0.09
Horse	0.80
Ass/mule	0.36

Source: Gryseels (1988) and Abdinasir (2000); Kelay (2002)

Annex 2: Analysis of variance on milk yield and reproductive performance of local and crossbreed cattle

		Sum of Squares	df	Mean Square	F	Sig.
AFC(yrs)L	Between Groups	78.559	1	78.559	89.330	.000
	Within Groups	242.723	276	.879		
	Total	321.282	277			
AMY(l/d/c)L	Between Groups	1031.749	1	1031.749	329.069	.000
	Within Groups	865.358	276	3.135		
	Total	1897.108	277			
ALL(m)L	Between Groups	7.645	1	7.645	1.606	.206
	Within Groups	1313.505	276	4.759		
	Total	1321.150	277			
AMYL(l)L	Between Groups	62319229.990	1	62319229.990	370.991	.000
	Within Groups	46362612.053	276	167980.478		
	Total	108681842.043	277			
CI(m)L	Between Groups	3005.658	1	3005.658	47.412	.000
	Within Groups	17497.05	276	63.395		
	Total	20502.70	277			

Annex 3: Analysis of correlation of different demographic characteristics of households and number of technologies

		AGE	Farm experienc	family size	Educational level	distance	TLA(ha)	No. of technologies uptake
AGE	Pearson Correlation	1	.983(**)	.099	-.487(**)	-.086	.346(**)	-.106
	Sig. (2-tailed)		.000	.125	.000	.185	.000	.101
	N	240	240	240	240	240	240	240
Farm experience	Pearson Correlation	.983(**)	1	.131(*)	-.474(**)	-.090	.347(**)	-.092
	Sig. (2-tailed)	.000		.043	.000	.162	.000	.157
	N	240	240	240	240	240	240	240
family size	Pearson Correlation	.099	.131(*)	1	.087	-.039	.454(**)	.221(**)
	Sig. (2-tailed)	.125	.043		.181	.552	.000	.001
	N	240	240	240	240	240	240	240
Educational level	Pearson Correlation	-.487(**)	-.474(**)	.087	1	-.117	-.180(**)	.269(**)
	Sig. (2-tailed)	.000	.000	.181		.071	.005	.000
	N	240	240	240	240	240	240	240
distance	Pearson Correlation	-.086	-.090	-.039	-.117	1	.163(*)	-.220(**)
	Sig. (2-tailed)	.185	.162	.552	.071		.011	.001
	N	240	240	240	240	240	240	240
TLA(ha)	Pearson Correlation	.346(**)	.347(**)	.454(**)	-.180(**)	.163(*)	1	.109
	Sig. (2-tailed)	.000	.000	.000	.005	.011		.093
	N	240	240	240	240	240	240	240
No. of technologies uptake	Pearson Correlation	-.106	-.092	.221(**)	.269(**)	-.220(**)	.109	1
	Sig. (2-tailed)	.101	.157	.001	.000	.001	.093	
	N	240	240	240	240	240	240	240

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Annex 4: Semi structure Questionnaire survey format

Date of interview ____/__/___ Code No_____Kebele___ Distance from Technology disseminating area (Kms) ____

Instruction: - First explain the purpose of interview to the households

I. Owners' profile

1. Owner Name_____________________________

2. Sex________Age: _________years

3. Family size ______

4. Level of education (encircle)

1. Illiterate 2. Read only 3. Elementary

4. Junior secondary 5. Secondary 6. Above secondary

5. Indicate members of household responsible for livestock management in this year. *(Tick)*

No.	**Activities**	**Children (<15yrs)**			**Adult ((≥ 15yrs)**		
		Boys	**Girls**	**Hired**	**Males**	**Females**	**Hired**
1.	Livestock purchasing and selling						
2.	Selling of dairy products						
3.	Milking						
4.	Making dairy products						
5.	Herding						
6.	Stall-feeding						
7.	Watering						
8.	Caring for sick animals						
9.	Barn cleaning						
10.	Others (specify)						

II. General farm information

1. Type of farming activity

1. Crop 2. Livestock 3. Crop and livestock

2. What are the main objectives of keeping dairy cattle (in their importance order)?

1. Cash income from sale of milk 3. Income from sale of milk & use of available labor

2. Source of milk for family 4. Other (Specify)_________________

3. Which breed type do you have?

1. Local 2. Crossbred 3. Pure breed

4. What is the reason for selecting breed? ____________________

5. Number of animals present in your farm in addition to cattle:

Species	**Number**	
cattle	**Local**	**Cross breed**
Cow		
Heifers		
Calves		
Bull		
Equine		
Horse		
Mule		
Donkey		
Poultry		
Small Ruminant		
Sheep		
Goat		

III. Production performance of herd

1. Production performance of herd

Variables	**Breed**	
	Local	**Crossbred**
Age at first calving (years)		
Average milk yield (lit/day/cow)		
Average lactation lengths (months)		
Average milk yield per lactation (lit.)		
Calving Interval (months)		

2. Constraints to cattle production. *(Rank 1-8 according to their importance)*

1. Shortage of grazing land 3.Health problem 5. Predator 7. Water scarcity

2. Low output 4.Scarcity of labor 6.Distress sale 8. Others

3. For what purpose livestock are kept? *(Rank 1-10 according to their importance)*

1. Meat____ 4. Transport ____ 7. Hides/skins____
2. Milk____ 5. Income ___ 8. Savings____
3. Work/draft ____ 6. Manure____ 9. Prestige status_____
10.Others____

IV. Land use Pattern

1. Total land area__________ (ha)
2. Land used for crop cultivation ___ (ha)
3. Land used for forage development___ (ha)
4. Land used for grazing__ (ha)

V. Feed resources and feeding systems

1. What are the major cattle feeding system you use?

1/ free grazing 3/ Grass from cut and carry (Zero grazing)

2/ rotational grazing 4/ stall-feeding

2. Do you grow any forage crop?

1. Yes 2. No

3. Is the grazing resource adequate for your animals?

1. Yes 2. No

4. What types of feed do you use?(encircle one or more)

1. Crop residues 4. Concentrates 7. Grass from grazing

2. Hay 5. Chemical treated straw 8. others____________

3. Silage 6. Mineral blocks

5. How do store your crop residues?

1) Stacked out side 3) Baled out side 5) Other (specify)___________

2) Stacked under shed 4) Baled under shade

6. For how long do you store the residues before feeding?

1) Soon after collection
2) Some month after collection
3) Two months after collection
4) Over Two months after collection

7. Which concentrate do you feed?

1. Grain 4. Flour mill by products

2. Oil seed cake/meal 5. Non-conventional feed

3. Commercial /mixed feed 6. Other (Specify)__________________

8. Do you face shortage of feed supply?

1. Yes 2. No

9. How do you coup up shortage of feed?

1. Reduce herd size 2.Purchase of concentrates 3. Buying crop residues

10. What are the constraints in feed and feeding cattle in the farm? (In their importance order)

VI. General herd management

1. Type of house used for cattle?

   1. Communal with the people 2. Isolated 3. simple fenced area(beret)

   Roof : 1. CIS 2. Thatch 3.plastic 4) Other ___________

   Wall : 1. full closed 2. Semi closed 3. Open 4) Other ___________

   Floor: 1. soil 2. Stone layer 3. Paved 4) Other ___________

2. What are the constraints on housing condition in the farm? (in their importance order)

3. What is the frequency of watering your cows?

   1. Once in a day 3.Three times in a day

   2. Twice in a day 4. Other: _________

4. How far is the watering site from your home? ------------------Km round trip

5. What is the source of water for milking cows?

   1. River 4. Ocean

   2. Well 5. Stream (Minch)

   3. Supplied (tank, pipe…) 6. Pond (kurie)

6. Do you practice washing of the udder?

   1. Yes 2. No

7. Why you practice washing of the udder?

   1. Improving milk quality 2. Stimulate milk let down 3) Other _________

8. What types of milking utensils do you use?

   1. Plastic recycled gallons 2. Metal bowls

   3. Traditional milking equipments 4. Others (specify)_________________

9. How many times do you milk a cow/day?

   1. One 2. Two 3. Three

10. Milking is mainly done by;

    1. Household male 2.Household female 3. Other female 4. Other male

11. Milk processing is mainly done by;

    1. Household male 2.Household female 3. Other female 4. Other male

12. Which method do you use for milk processing?

    1. Traditional 2. Modern

13. Which milk product is highly preferred in the area?

    1. butter 2. cheese 3. yoghurt 4. others

14. Do you get any training how to keep milk clean? 1. Yes 2. No

15. Is culling practiced?

1. Yes 2. No

16. Why you practiced culling? (Rank accordingly)

1. Health problem ______ 5)Color of the animal_____
2. Production performance______ 6)Size and posture________
3. 3)Old age _______ 7)Others (specify)__________

4) Fertility problem______

17. What do you do on production case culled cows?

1. Sell 2. Slaughter

18. What are the problems that you faced during selling the culled cows?

1. Buyers scarcity 2. Distance of market 3. Price 4. Other specify______

19. Do you have organized records?

1. Yes 2. No

20. What types of records do have?

1. Feeding 3. Calving date 5. Cost and profit
2. Health 4. Milk production 6. Other specify

21. Do you get any assistance about recording?

1. Yes 2. No

22. If yes, from where do you get?

1. Developmental agent from your kebele
2. "woreda" agricultural and developmental office
3. From NGOs
4. Others specify____________________________

23. Mention the advantages of recording?

1. ______________________ 2.____________________
3.______________________ 4.____________________
5.____________________ 6.____________________

VII. Livestock health

1. Do you encounter livestock death?

1. Yes 2. No

2. How many animals are died this year? (In number)

	No of animals died	Possible causes of death
Calves		
Heifers		
Bulls		
Cows		

3. How is bloating treated?

1. Traditionally 2. Modern means 3. Not treated

4. What are the most infectious livestock diseases in the area? (Rank in the order of importance)

Livestock class		Name of livestock disease*								
		Mas.	Bru.	RFM	FMD	BTC	Pas	Ant	Bl	Others
Local names→										
1.	Calves									
2.	Cow									
3	Heifers									
4	Bulls									

** = Mas- Mastitis; Bru- Brucellosis; Retained Fetal Membrane; FMD- Foot and mouth diseases; Pas- Pasturellosis; Ant- Anthrax; Bl-Blacklegs*

5. what type of veterinary services do you get? *(encircle one or more)*

1. Government veterinarian 3. Shop or market.

2. Private veterinarian 4. Others (specify)_______________

6. Is vaccination practiced in the area?

1.Ye s 2. No

7. For which diseases do you practice vaccination?

1. Mastitis 5. Pastureollosis
2. Black leg 6. Foot and mouth diseases
3. Brucellosis 7. Anthrax
4. Retained Fetal Membrane 8. Others (specify)___________

8. What are the problems that you faced during vaccination?

1. Vaccination not required   3. No veterinarian
2. Vaccine not available   4. Others (specify)________________

9. What is the ecto- parasite control method for livestock?

1. Traditional   2. Modern   3. Not treated

10. What is the endo- parasite control method for livestock?

1. Traditional   2. Modern   3. Not treated

11. Do you have access to veterinary services?

1. Yes   2. No

12. Who has given health services?

1. Agricultural bureau   2. NGO   3.Others (Specific)__________________

VIII. Livestock reproduction

1. Indicate livestock breed types exist in your herd.

Parameters		Cattle
1.	Average age at sexual maturity (in years)	
2.	Average age at 1st calving (in years)	
3.	Average calving interval (in months)	

2. What is the main reason for keeping male animal(s)?

1. for mating   2. Socio-cultural   3. Draft/work   4. Others (specify) __________

3. Do you castrate male animals?

1. Yes   2. No

4. Which castration method do you use?

1. Traditional   2. Modern   3. None

5. Reasons for castrating male animals?

1. To abstain from breeding   2. Meat production   3. draft   4. Others (specify) _____

6. Have you participated in livestock extension package in the past?

1. Yes   2. No

VIIII. Livestock marketing

1. Do you sell live animals this year?

1. Yes   2. No

2. Indicate distance of livestock market place?

1. < 5km 2. 5 -10km 3. >10km 4. Neighboring “woreda”s 5. Others (specify)

3. Do you sell livestock products?

1. Yes 2. No

X. Animal breeding

1. Do you detect estrus/heat in cow/ heifers?

1. Yes 2. No

2. Do you select superior females for breeding?

1. Yes 2. No

3. what are the characteristics used to identify superior females ?_______ , ______ , ____

4. What types of breeding practices do you use for dairy cow?

1. Natural bull services 2. Artificial insemination (AI) 3. Both

5. What is the source of AI services?

1. Government recruited technicians 2. NGO

3. Private 4. Other specify

6. Is there a problem of AI?

1. Yes 2. No

7. If yes, why?

1. No access 2. Unwillingness of AI technicians 3. Shortage of liquid nitrogen 4. Remoteness of the area from AI service center

5. Other specify___________

8. Which method do you prefer?

1. Natural 2. Artificial Insemination

9. Why you prefer?

1. _________ 2. ________ 3. _________

4. ___________ 5. ___________ 6. _________

10. Which breed do you use in the future?

1. Local 2. Cross 3. Both

11. From where do you get cross breed cows?

1. Buying from Government farms 2. NGOs support 3. Buying from private farms 4. Others specify

12. Do you practice pregnancy testing?

1. Yes 2. No

13. If yes, who detect the pregnancy?

1. The owner 2. Herd man 3. Professional person 4. Others

14. What methods do you use for pregnancy detection?

1. Observing the bell of the cow 3. Refusing calf suckling

2. Milk production decrement 4. Others

15. What are animal breeding constraints?__________ , ___________ , ___________

XI. From where did you get information regarding to dairy technology?

Types of tech.	**Sources tech. information**			
	government	**NGO(specify)**	**Neighbor**	**Starting time**
Feeding system				
Forage development				
Improved housing				
Modern castration				
Animal breeding				
Milk processing				
Record keeping				
culling				

XII. Constraint of dairy technology uptake

1. Prioritize the problems of dairy farms in their importance order (From economical and social points of view).

1. _________________________________ 5. _________________________________

2. _________________________________ 6. _________________________________

3. _________________________________ 7. _________________________________

4. _________________________________ 8. _________________________________

XIII. What you need to be done by the government and other organization in the future?

1. ________________________ 4. ____________________ 7. ___________________

2. ________________________ 5. ____________________ 8. ___________________

3. ________________________ 6. ____________________ 9.___________________

Annex 5: Questionnaire format for group discussion

Form 1; Milk production

Milk use categories

Date____________ Group___________ Area____________ Number of participants__________

Date of establishment of Dairy technology /milk unit/ in the area__________

Method: Proportional piling, Scoring: before and after uptake of dairy Technology

Uses of milk in the area	Before period (Score)	after period (Score)	Comment from participants
1			
2			
3			

Checklist questions

What was the amount of milk yield in your area?

Is the milk yield increased or decreased in the before technology uptake period?

If 100 seeds represent the daily quantity of milk produced, increase, decrease or let remain the same the Pile maize seeds in the after technology transferred period

What are the different uses of milk in this area?

If 100 seeds represent the daily quantity of milk produced in the herd, divide this seeds to the mentioned uses.

Has this increased, decreased or remained the same after the uptake of dairy technology. Reduce, increase or leave the heap, as it is then score the uses.

Form 2: Disease status before and after starting use of modern veterinary services

Date________________ Group_______________ Area________________

Number of participants_______________

Method: Proportional piling, Scoring: before and after starting use of modern veterinary services

Disease	Before period (Score)	after period (Score)	Comments from participants
1			
2			

Checklist questions;

What are the major diseases that decrease milk production dairy cattle in your area?

What are the major diseases that emaciate dairy cattle in your area?

What are the major diseases that kill dairy cattle in your area?

If 100 maize seeds are, the dairy cattle that decrease milk yield from these diseases, which diseases are the causes for this milk production decrement on dairy cattle before the uptake of technology in the study area?

If 100 maize seeds are, the dairy cattle that emaciated dairy cattle, which diseases are the causes for this emaciation of dairy cattle before the uptake of technology in the study area?

If 100 maize seeds are the dairy cattle that died from these diseases, which disease killed what number of dairy cattle before the uptake of technology in the area?

Has the milk production decrement increased, decreased or it remained the same, adds to the heap decrease or remains the same and scores for the situation after the uptake of dairy technology

Has the number of emaciated dairy cattle, decreased or it remained the same, adds to the heap decrease or remains the same and scores for the situation after the uptake of dairy technology

Has the death increased, decreased or it remained the same, adds to the heap decrease or remains the same and scores for the situation after the uptake of dairy technology.

Observational/Comments____
_

Form 3 Use of different types of veterinary services before and after the dairy technology transferred to the area.

Date____________ Group_________ Area___________ Number of respondent________________

Method: Proportional piling, Scoring: before and after uptake of modern animal health technologies

	Animal Health Services	Before period (Score)	after period (Score)	Remark
1				
2				

Checklist question

Think of different uses of different types of veterinary services in your area.

If 100 piles of maize seeds represent the veterinary services before the dairy technology/ies was/ were transferred in the area, divided this pile according to the mentioned services. Now with the presence of dairy technology in the area is there increase, decrease or let the pile remains the same and make scoring again on the same mentioned veterinary services

Annex 6: Questionnaire format for extension servants

Date_______/___/_____ Name___________ Code_______ Educational level________

1. Do you assist the farmers to uptake the new technology?

1. Yes 2. No

2. How do you assist the farmers?

1. High frequently 2. Frequently 3. Rarely

3. How the farmers uptake the technologies?

1. Early 2. Moderately 3.Lately

4. Constraint of dairy technology uptake

1. Prioritize the problems of dairy farms in their importance order (From economical and social points of view).

1. ______________________________ 5. ______________________________
2. ______________________________ 6. ______________________________
3. ______________________________ 7. ______________________________
4. ______________________________ 8. ______________________________

CURRICULUM VITAE

PERSONAL DETAILS

Name: Dehinenet Gezie Woldmichael

Date of birth: 5 June 1973

Place of birth: Lumamme (Awabel “woreda”), East Gojjam

Nationality: Ethiopian

Sex: Male

Date of recruitment: February 8, 1992

Present position: Senior Instructor in Animal Science Department in Mertule Mariam Agricultural, Technical, vocational, Educational and Training (ATVET) College

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EDUCATIONAL QUALIFICATIONS

1992 I appeared on ESLCE for the first time but I was not successor to pass that Ethiopian School Leaving Certificate Examination (ESLCE) and employed as an elementary school teacher after taking a year course on teaching in Debre brehan teacher training Institute (TTI).

1999 I have scored a great distinction result and joined Mekelle University in 2000.

2003 I was awarded a Bachelor of Science (B.Sc.) degree in animal science from Mekelle University, Faculty of agriculture, Ethiopia.

WORK EXPERIENCE

1. Before B.Sc. graduation, by certificate, I have served for six years (1994-1999) as a head master and an elementary school teacher.
2. After graduation, I hired in Mertule Mariam ATVET College as Instructor in 2003 and still I am serving there as senior instructor.
3. Through this instructor service years I also acted as a department head for two years from 2003 to 2005.

ADDITIONAL TRAININGS

- ►Certificate on head master courses for elementary school from Debre Brehan teacher raining Institute (DBTTI)
- ►Certificate on Computer proficiency from universal computer center
- ►Certificate in seri –culture from Korea seri-culture project
- ►Certificate in poultry production and feeding management from Ethiopia Agricultural research Organization

STUDY PAPERS PRODUCED

- ►Methods of improving the nutritive values of crop residues for dairy cattle feed Seminar on current topics (2007) FVM, AAU
- ►Smallholder dairy production technologies uptake in mixed farming system in Dejen “woreda” of East Gojjam zone, Amhara Regional State, Ethiopia (Debre zeit MSC Thesis (2008))

PROFESSIONAL ASSOCIATION

I am a member of Ethiopian Society of Animal Production (ESAP).

REFERENCES

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SIGNED DECLARATION SHEET

This thesis is my original work, it has not been presented for a degree in any University, that all sources of material used for the thesis have been duly acknowledged.

Name: Dehinenet Gezie: ____________________________

Date of submission: June 2008.

This thesis has been submitted for examination with our approval as University advisors:

Mekonnen Hailemariam (DVM, MVS, Associate professor): ___________

Kelay Belihu (DVM, PhD, Assistant professor): ____________